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MEMOIRS OF THE HOURGLASS CRUISES

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PENAEOID AND SERGESTOID SHRIMPS (CRUSTACEA: DECAPODA)

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By

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ABSTRACT

Three families of Penaeoidea and one genus of Sergestidae were captured during 28 months of systematic sampling on Florida's west central shelf. Penaeoids collected in order of decreasing abundance were *Sicyonia brevirostris*, *Solenocera atlantidis*, *Metapenaeopsis goodei*, *Penaeus duorarum*, *Trachypenaeus constrictus*, *Mesopenaeus tropicalis*, *Sicyonia typica*, *Sicyonia laevigata*, *Sicyonia stimpsoni*, and *Sicyonia burkenroadi*. These species have demonstrable affinities for firm or coarse substrates; penaeoids with soft or fine substrate affinities were not captured in Hourglass sampling. Sergestidae was represented by the planktonic shrimp, *Lucifer faxoni*.

Reproductive data revealed a trend toward protracted or year-round spawning and recruitment.

Diet analysis revealed eight penaeoids to be generalized benthic carnivores. Nocturnal feeding was indicated for seven; *S. laevigata* had a diel feeding pattern.

A key for 26 species of Penaeoidea known from the Gulf of Mexico and Atlantic waters of Florida's east coast (less than 200 m deep) includes *Trachypenaeopsis mobilispinis*, not previously reported from waters contiguous to Florida.

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INTRODUCTION

Penaeoids on shallow continental shelves of the Gulf of Mexico are heavily exploited as an important food source. Even though Mexican waters were partially closed to United States shrimping fleets in 1976, 52% of total U.S. landings (101 x 10^6 kg) came from the Gulf (U.S. Dept. of Commerce, 1977). Three *Penaeus* species and one *Sicyonia* are mainstays of this fishery; two of these, *Penaeus duorarum* and *Sicyonia brevirostris*, occurred in Hourglass samples.

Burkenroad (1934a, b, 1939) gave excellent accounts of many shrimps encountered in shallower waters of the northern Gulf of Mexico, and Roberts and Pequegnat (1970) inventoried and discussed deep water species from the Gulf. These studies and most others were not derived from systematic sampling, and some potential life history information has been consequently undiscernable. Systematic sampling (continued regular visits to established stations) has generally been confined to estuaries and bays more amenable to this type program (e.g. Eldred et al., 1965; Brusher and Ogren, 1976). Studies of shrimps from offshore systematic sampling which have yielded ontogenetic information include those of Brusher et al. (1972), Franks et al. (1972), and Kennedy et al. (1977). Similar data has also been derived from studies of fauna associated with commercial species (Hildebrand, 1954, 1955; Joyce, 1965; Bryan and Cody, 1975 a, b). Project Hourglass, conducted from August 1965 through November 1967 at ten stations, notably increased fundamental knowledge of penaeoid shrimps on Florida's central Gulf shelf.

ACKNOWLEDGMENTS

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Dr. Isabel Pérez Farfante reviewed the manuscript and offered valuable criticisms and suggestions. Her time and efforts are immeasurably appreciated.

METHODS AND MATERIALS

All examined specimens were obtained from Project Hourglass sampling at two transects, each with five stations in depths of 6, 18, 37, 55 and 73 m off Tampa Bay and Sanibel Island (Figures 1, 2; Table 1). Samples were collected with a box dredge (15 min bottom tow) and standard (6.1 m wide) trynet (30 min bottom tow). Supplementary trawling utilized a larger (13.7 m wide) balloon otter trawl at all stations. Terms referring to these techniques are: *regular sampling* - monthly night collections at all stations; *supplementary trawls* - night collections at all stations with the large otter trawl during July 1966 and January 1967; *diurnal sampling* - monthly day collections at Stations B, C, and D only (usually made about two weeks after regular sampling). Detailed methods and station data may be found in Joyce and Williams (1969).

Most specimens were measured to nearest 0.1 mm with vernier calipers; discarded shrimp were measured to nearest mm. Small specimens were measured with ocular micrometers. Standard measures were carapace length (CL), measured from the orbital margin of the orbit to the dorsal posterior carapace

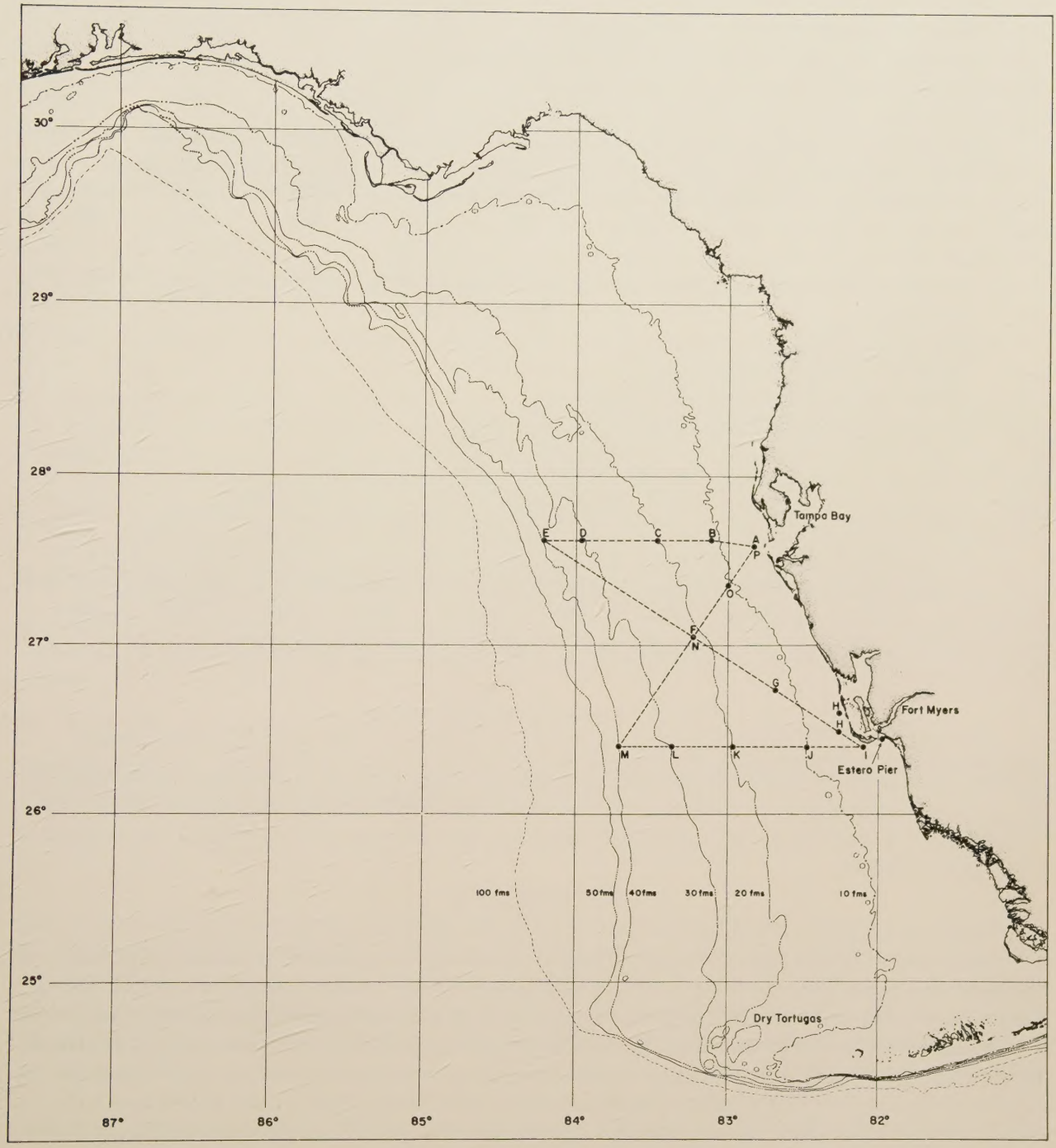


Figure 1. Hourglass station locations and cruise pattern.

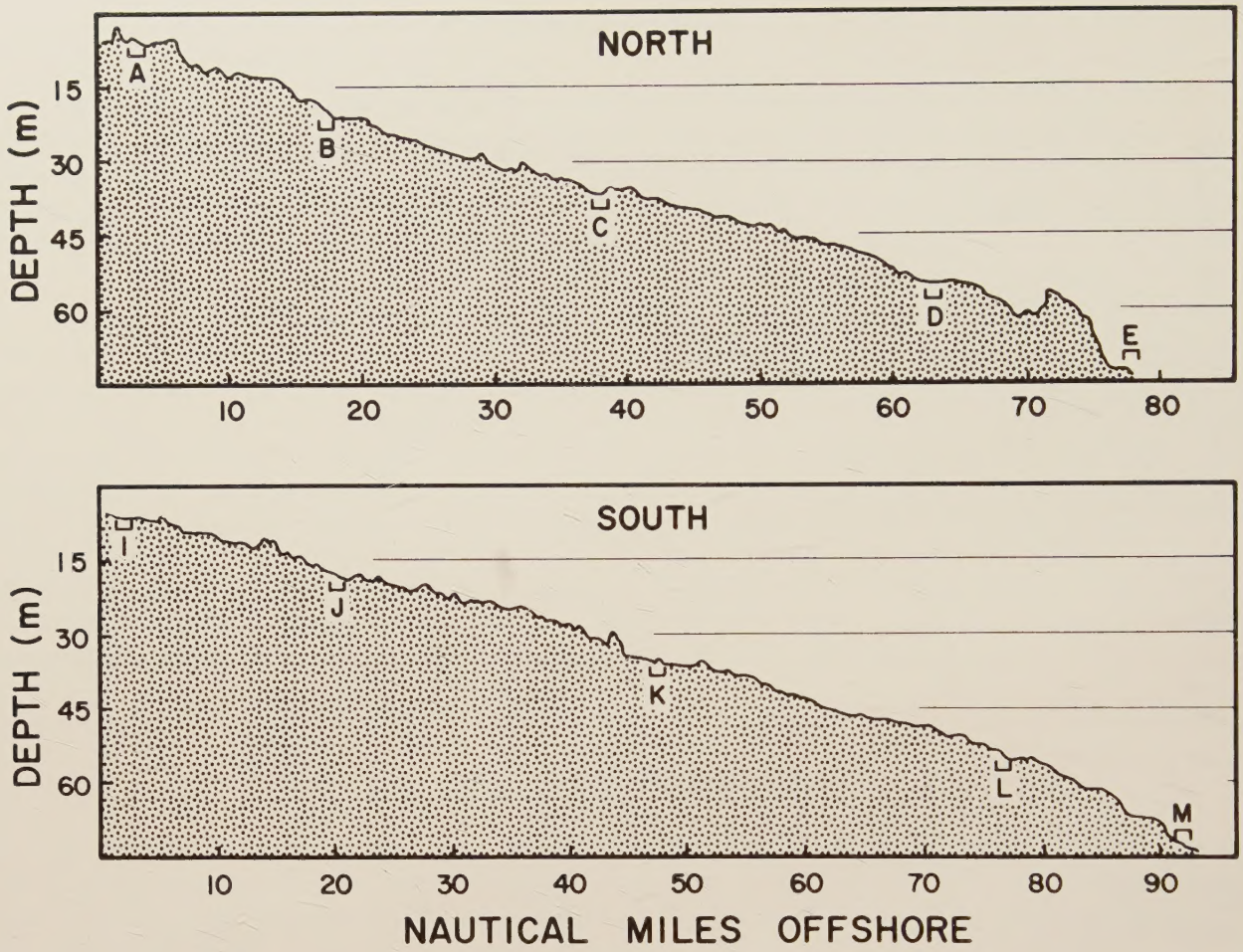


Figure 2. Bathymetry of Hourglass transects.

margin; total length (TL), used for discarded specimens, was measured from rostrum tip to telson tip. Measurements presented in material examined sections were mm CL unless followed by "(TL)". Total weight (WT) was determined with a triple beam balance to nearest 0.01g; small specimens were weighed on a Mettler H-5 balance.

Length frequencies were determined for 1 mm CL size classes (2 mm CL for *Sicyonia brevirostris*). Collections from like months of the last two years of sampling were combined to produce sufficient numerical representations. The number in each size group was presented as a percentage of modal size class for that month. Discarded *Penaeus duorarum* and *Sicyonia brevirostris* total lengths were converted to carapace lengths and included in their respective length frequencies. *Penaeus duorarum* TL-CL conversions were from McCoy (1972).

Determinations of linear and exponential relationships (CL-TL, CL-WT) followed methods of Sokal and Rohlf (1969). Statistical testing (ANCOVA) followed methods of Snedecor and Cochran (1967). Other specific data treatments may be found in systematic accounts.

Ovarian development stages of selected species were determined by observation of cytoplasmic granulation, visibility of nuclei, and presence or absence of peripheral bodies from smear and histological preparations (King, 1948; Cummings, 1961; Cobb et al., 1973). Macroscopic reproductive assessments

TABLE 1. LOCATION OF HOURGLASS STATIONS.

Station	Latitude*	Longitude*	Established Depth (meters)	Approximate Nautical Miles Offshore*
A	27°35′N	82°50′W	6	4, due W of Egmont Key
B	27°37′N	83°07′W	18	19, due W of Egmont Key
C	27°37′N	83°28′W	37	38, due W of Egmont Key
D	27°37′N	83°58′W	55	65, due W of Egmont Key
E	27°37′N	84°13′W	73	78, due W of Egmont Key
I	26°24′N	82°06′W	6	4, due W of Sanibel Island Light
J	26°24′N	82°28′W	18	24, due W of Sanibel Island Light
K	26°24′N	82°58′W	37	51, due W of Sanibel Island Light
L	26°24′N	83°22′W	55	73, due W of Sanibel Island Light
M	26°24′N	83°43′W	73	92, due W of Sanibel Island Light

*U. S. Coast and Geodetic Chart 1003 dated June, 1966.

were made by observing ovary color and spermatophore attachment to females. Sizes at female sexual maturity were determined from assessments of ovarian development (developed stage). Coupling of petasmal endopods was the criterion for assessing size at male sexual maturity. Sex ratios were calculated as decimal fractions (male N /female N) and selectively tested by Chi-square as suggested by Sokal and Rohlf (1969).

Diets were evaluated for selected well-represented species in our collections. Food was identified and classified as predominant or residual; predominant material was that which distinctly composed most stomach remains, and residual items were identifiable fragments occurring in small or trace quantities (Hall, 1962).

Shrimps recovered from fish stomachs do not appear in occurrence tables but are listed in individual species treatments. Not all Hourglass fish stomachs have been examined; relative importance to diets of predatory species can not be ascertained from these listings.

SYSTEMATICS

Recent systematic treatments by Glaessner (1969) and Pérez Farfante (1977) have established the families Solenoceridae, Aristeidae, Penaeidae, and Sicyoniidae within the superfamily Penaeoidea. Organization of this report follows this taxonomic arrangement. Our key, restricted to shrimps occurring in the Gulf of Mexico and off Florida's east coast to depths of 200 m, was derived from our own observations and from published, general comprehensive taxonomic treatments (Voss, 1955; Williams, 1965; Chace, 1972). Detailed keys used include: Pérez Farfante (1977), Solenoceridae; Pérez Farfante and Bullis (1973), *Solenocera*; Pérez Farfante (1971), *Metapenaeopsis*; and Pérez Farfante (1969, 1970), *Penaeus*. Deep water species (beyond 200 m) may be identified utilizing keys developed by Roberts and Pequagnat (1970).

Inclusion of *Trachypenaeopsis mobilispinis* (Rathbun, 1919) in the key is based upon a single male specimen (7.5 mm CL) captured near Jupiter Inlet, Florida east coast, in 1971 and cataloged (FSBC I 8667) in the Florida Department of Natural Resources (FDNR) Invertebrate Reference Collection. This is apparently the only known specimen from Florida waters.

Synonomies were restricted to references dealing with specimens from the Gulf of Mexico or the Atlantic Ocean off Florida's coast. References in which localities of capture were unclear or unknown were generally excluded. If a nominal species occurred within this geographical restriction, the reference in which the nominal species was described was cited regardless of type locality. *Penaeus duorarum* was additionally restricted to references published after those cited by Pérez Farfante (1969). References to *Lucifer faxoni* were limited to those of occurrences in the eastern Gulf of Mexico.

KEY TO PENAEOIDEA OF THE GULF OF MEXICO AND FLORIDA'S ATLANTIC COAST IN DEPTHS LESS THAN 200 METERS

1. Fourth and fifth pereopods reduced or absent (Sergestidae) 1
   [Note: One species, *Lucifer faxoni*, Borradaile, 1915.]

1. Fourth and fifth pereopods well developed (Penaeoidea) 2
   [Note: Aristeidae not treated; see Roberts and Pequegnat, 1970].

2. Postorbital spine absent 3

2. Postorbital spine present (Solenoceridae) 4

3. Postrostral carina extending and prominent to or nearly to posterior margin of carapace; at least one tooth on posterior half of carina (Sicyoniidae) 10

3. Postrostral carina less prominent on posterior third of carapace, sometimes absent near posterior margin of carapace; if carina present to posterior margin, no teeth on posterior half (Penaeidae) 16

4. Dorsal antennular flagellum subcylindrical; ventral flagellum subcylindrical or flattened; lateral ramus of uropod armed with distolateral spine 5

4. Dorsal and ventral antennular flagella lamellate; lateral ramus of uropod lacking distolateral spine ... 8

5. Branchiostegal spine absent; ventral antennular flagellum conspicuously depressed, channel-like; orbital and hepatic spines present, pterygostomian spine absent; distal article of mandibular palp armed with unique distomesial series of hooks. Depth range 30-915 m ..... *Mesopenaeus tropicalis* (Bouvier, 1905)

5. Branchiostegal spine present 6

6. Orbital spine present; carapace and abdomen pubescent; ventral margin of rostrum concave to nearly straight. Depth range 180-730 m ..... *Pleoticus robustus* (Smith, 1885)

6. Orbital spine absent; carapace variously pubescent, abdomen generally naked, polished; ventral margin of rostrum convex 7

7. Scaphocerite reaching distal end of antennular peduncle or overreaching it by not more than 0.10 of its own length; prosartema extending only to distomesial extremity of first antennular article; thelycum with median protuberance on sternite XIV projecting ventrally, tooth of median keel of sternite XII directed anteriorly; petasma with distomesial projection of ventromedian lobule directed mesially. Depth range 165-570 m ..... *Hadropenaeus affinis* (Bouvier, 1906)

7. Scaphocerite exceeding antennular peduncle by about 0.25 of its own length; prosartema conspicuously overreaching distomesial margin of first antennular article; thelycum with median protuberance on sternite XIV projecting anteriorly, tooth of median keel of sternite XIII directed ventrally or posteri-

orly; petasma with distomesial projection of ventromedian lobule directed distally. Depth range 150-550 m ..... *Hadropenaeus modestus* (Smith, 1885)

8. Orbital spine absent; rostral + epigastric teeth 5-8, usually 6; scaphocerite exceeding antennular peduncle by more than 0.10 its own length; postrostral carina low or absent posterior to cervical sulcus. Depth range 160-550 m ..... *Solenocera necopina* Burkenroad, 1939

8. Orbital spine present (may be minute) 9

9. Rostral + epigastric teeth 4-7, usually 6; anterior part of carapace with short setae; postrostral carina ending at level of cervical sulcus; orbital spine minute; pterygostomian spine small, with narrow base, its dorsal margin joining carapace at right angle (spine sometimes doubled). Depths less than 130 m ..... *Solenocera atlantidis* Burkenroad, 1939

9. Rostral + epigastric teeth 8-11, usually 9; anterior part of carapace naked; postrostral carina almost reaching posterior margin of carapace; orbital spine short, acute; pterygostomian spine broad at base, not conspicuously produced, often slightly inclined ventrally. Depth range 35-240m ..... *Solenocera vioscai* Burkenroad, 1934

10. Antennal angle unarmed with definite spine; ischium of first pereopod armed with a spine 11

10. Antennal angle armed with definite, buttressed spine; ischium of first pereopod unarmed 12

11. Rostrum with two dorsal teeth anterior to level of orbital margin; postrostral carina with three subequal teeth, anterior tooth smallest; first abdominal pleuron with distinct posteromedian sulcus; other pleural sulci of first somite indistinct. Depths less than 90 m ..... *Sicyonia laevigata* Stimpson, 1871

11. Rostrum with three dorsal teeth; postrostral carina with three evenly spaced, subequal teeth; first abdominal pleuron with distinct antero- and posteromedian sulci, posterior pleural sulcus distinct. Depths less than 30 m ..... *Sicyonia parri* Burkenroad, 1934

12. Postrostral carina with three or four teeth, three large and placed far posterior to orbital margin. Depths less than 330 m ..... *Sicyonia brevirostris* Stimpson, 1871

12. Postrostral carina with two or three teeth, one or two large 13

13. Postrostral carina with two or three teeth, two large and placed far posterior to orbital margin behind level of hepatic spine. Depths less than 68 m ..... *Sicyonia typica* (Boeck, 1864)

13. Postrostral carina with two teeth, only one large and placed far posterior to orbital margin behind level of hepatic spine 14

14. Fourth abdominal pleuron with anteroventral margin angulate, posteroventral margin angulate or with posteriorly directed spine. Depths less than 420 m ..... *Sicyonia dorsalis* Kingsley, 1878

14. Fourth abdominal pleuron with posteroventral margin rounded 15

15. First abdominal pleuron with ventral angulate apex. Posterior tergal carina of fourth abdominal somite produced into definite subterminal, posteriorly directed tooth; distinct laterodorsally curved spines on ventral apex of first four abdominal pleura. Depth range 33-118 m *Sicyonia burkenroadi* Cobb, 1971

15. First abdominal pleuron ventrally rounded, with no distinct ventral or anteroventral angular apex; posterior tergal carina of fourth abdominal somite not produced into posteriorly directed tooth; no distinct laterodorsally curved spines on ventral apex of first four abdominal pleura (small, ventrally directed obtuse teeth sometimes present). Depth range 73-411 m . . *Sicyonia stimpsoni* Bouvier, 1905

16. Rostrum with ventral teeth 17

16. Rostrum without ventral teeth 20

17. Adrostral sulcus short, extending to epigastric tooth; gastrofrontal carina absent. Depths less than 82 m . ..... *Penaeus setiferus* (Linné, 1767)

17. Adrostral sulcus long, extending posteriorly beyond epigastric tooth; gastrofrontal carina present 18

18. Petasma with long distomedian projection; distal fold intruding considerably inside petasma, forming large auricle; ventral costa with apex free; lateral plates of thelycum with anteromedial corners extended anteriorly, forming two projections covering posterior process. Depths less than 274 m .... *Penaeus brasiliensis* Latreille, 1817

18. Petasma with relatively short distomedian projection; distal fold not forming auricle; ventral costa with apex attached to adjacent membranous portion; lateral plates of thelycum with anteromedial corners not extended, posterior process exposed 19

19. Petasma with distal portion of ventral costa armed with minute spines along free border, broadening and turning proximally rather abruptly; lateral plates of thelycum with anteromedian corners slightly divergent, posterior process with undivided median carina; dorsolateral sulcus of sixth abdominal somite narrow, often almost closed. Depths less than 329 m . *Penaeus duorarum* Burkenroad, 1939

19. Petasma with distal portion of ventral costa unarmed along free border, arc-shaped, gradually broadening and gradually turning proximally; lateral plates of thelycum with anteromedian corners widely divergent, posterior process with median carina bifurcate anteriorly; dorsolateral sulcus of sixth abdominal somite broad. Depths less than 165 m ..... *Penaeus aztecus* Ives, 1891

20. Rostrum slender, sinuous, without dorsal teeth on distal half. Depths less than 44 m .... *Xiphopenaeus kroyeri* (Heller, 1869)

20. Rostrum dorsally dentate to near tip 21

21. Pterygostomian spine absent; longitudinal sulcus weakly or strongly expressed; pubescence absent or partial on carapace and /or abdomen. 22

21. Pterygostomian spine present; no longitudinal sulcus on carapace; entire carapace and abdomen pubescent 25

22. Branchiostegal spine well developed, placed slightly posterior to anterior margin of carapace; longitudinal sulcus well developed, extending from above antennal spine to near posterior margin of carapace. Depth range 27-330 m ..... *Parapenaeus longirostris* (Lucas, 1849)

22. Branchiostegal spine absent; longitudinal sulcus weakly expressed, sometimes indistinct, fading posteriorly, not approaching posterior margin of carapace 23

23. Rostrum short, not extending beyond distal margin of eye; basis of second pereopod unarmed. Shallow water ..... *Trachypenaeopsis mobilispinis* (Rathbun, 1919).

23. Rostrum relatively long, extending beyond distal margin of eye by at least 0.33 its own length; basis of second pereopod armed with long, slender spine 24

24. Ventral surfaces of thelycum pubescent, lateral plates paddle-shaped, widely divergent at anteromedian corners, anterior margin of median process convex; males with sternal elevation between coxae of fifth pereopods goblet-shaped, constricted posteriorly; abdomen glabrous except for narrow line of pubescence on each side of dorsal carina of somites five and six. Depths less than 59 m .... *Trachypenaeus constrictus* (Stimpson, 1871)

24. Ventral surfaces of thelycum naked, lateral plates rectangular or truncated, not divergent at antero-median corners, anterior margin of median process truncate, slightly depressed at median portion; male with sternal elevation between coxae of fifth pereopods triangular, sloping regularly to posterior apex; last three abdominal pleura variously pubescent. Depths less than 80 m ..... *Trachypenaeus similis* Smith, 1885

25. Thelycum with median plate bearing horseshoe-shaped marginal strip and embracing paired coiled strips; petasma with distoventral projection cleft by deep sinus into two long, subequal lobes; abdominal carina clearly expressed on last three somites. Generally shallow water ..... *Metapenaeopsis smithi* (Schmitt, 1924)

25. Thelycum with median plate lacking marginal and coiled strips; petasma with distoventral projection simple, forming single lobe or cleft by shallow sinus into two short, subequal lobes or two unequal lobes; abdominal carina clearly expressed on last four segments 26

26. Scaphocerite reaching at most base of dorsal antennular flagellum. Thelycum with anterior part of median plate convex ventrally, bearing two large pits; petasma with distoventral projection mitten-like in outline, large left lobe far exceeding small right lobe. Generally shallow water ..... *Metapenaeopsis gerardoi* Pérez Farfante, 1971

26. Scaphocerite exceeding base of dorsal antennular flagellum by about 0.25 flagellum length. Thelycum with anterior part of median plate concave ventrally; petasma with distoventral projection cleft into two unequal lobes, right lobe noticeably larger than left. Generally shallow water ..... *Metapenaeopsis goodei* (Smith, 1885)

Family Solenoceridae Wood Mason, 1891
Genus *Mesopenaeus* Pérez Farfante, 1977

Mesopenaeus tropicalis (Bouvier, 1905)

Figure 3

Parartemesia tropicalis Bouvier, 1905, p. 748; Pérez Farfante, 1977, pp. 340, 341.

Haliporus tropicalis: Bouvier, 1906, p. 4; A. Milne Edwards and Bouvier, 1909, p. 217, figs. 45-54, pl. 3, figs. 1-9.

Hymenopenaeus tropicalis: Burkenroad, 1936, p. 103; Anderson and Lindner, 1945, p. 288; Springer and Bullis, 1956, p. 8; Bullis and Thompson, 1965, p. 5; Williams, 1965, pp. 14-17, figs. 6, 7; Roberts and Pequegnat, 1970, pp. 29, 30; Pequegnat and Roberts, 1971, pp. 8, 9; Pérez Farfante, 1977, pp. 262, 332, 341.

Solenocera weymouthi Lindner and Anderson, 1941, pp. 181-187, fig. 1; Anderson and Lindner, 1945, p. 286; Williams, 1965. pp. 15-17; Roberts and Pequegnat, 1970, p. 30; Pérez Farfante, 1977, p. 341.

Mesopenaeus tropicalis: Pérez Farfante, 1977, pp. 261-265, 332-341, figs. 9, 34, 56-63.

Material examined: HOURGLASS STATION A: 1♀, 13.0; 5 February 1967; dredge; FSBC I 8181. — HOURGLASS STATION B: 1♂, damaged; 1♀, damaged; 7 February 1966; trawl; FSBC I 8958. — HOURGLASS STATION C: 1 damaged; 5 February 1967; trawl; FSBC I 8964. — 1♀, 10.3; 1 damaged; 1 August 1967; trawl; FSBC I 8974. — HOURGLASS STATION D: 4♀, 19-24 (TL); 7 April 1966; dredge; discard. — 1♂, 5.6; 3 May 1966; dredge; FSBC I 16622. — 1♂, 2.3; 3 March 1967; dredge; FSBC I 8965. — 2♀, 3.4, 16.7; 3 November 1967; trawl; FSBC I 8978. — HOURGLASS STATION E: 2♂, 10.3, 11.4; 3♀, 13.0-16.3; 4 January 1966; trawl; FSBC I 2001. — 1♂, 7.7; 3♀, 2.7-4.9; 4 March 1966; trawl; FSBC I 8959. — 1 damaged, 4.0; 1 September 1966; dredge; FSBC I 16621. — 1♂, 53(TL); 5♀, 43-61(TL); 9 October 1966; trawl; discard. — 2♀, 16.2, 16.5; 9 October 1966; dredge; FSBC I 15805. — 2♀, 14.2, 17.3;

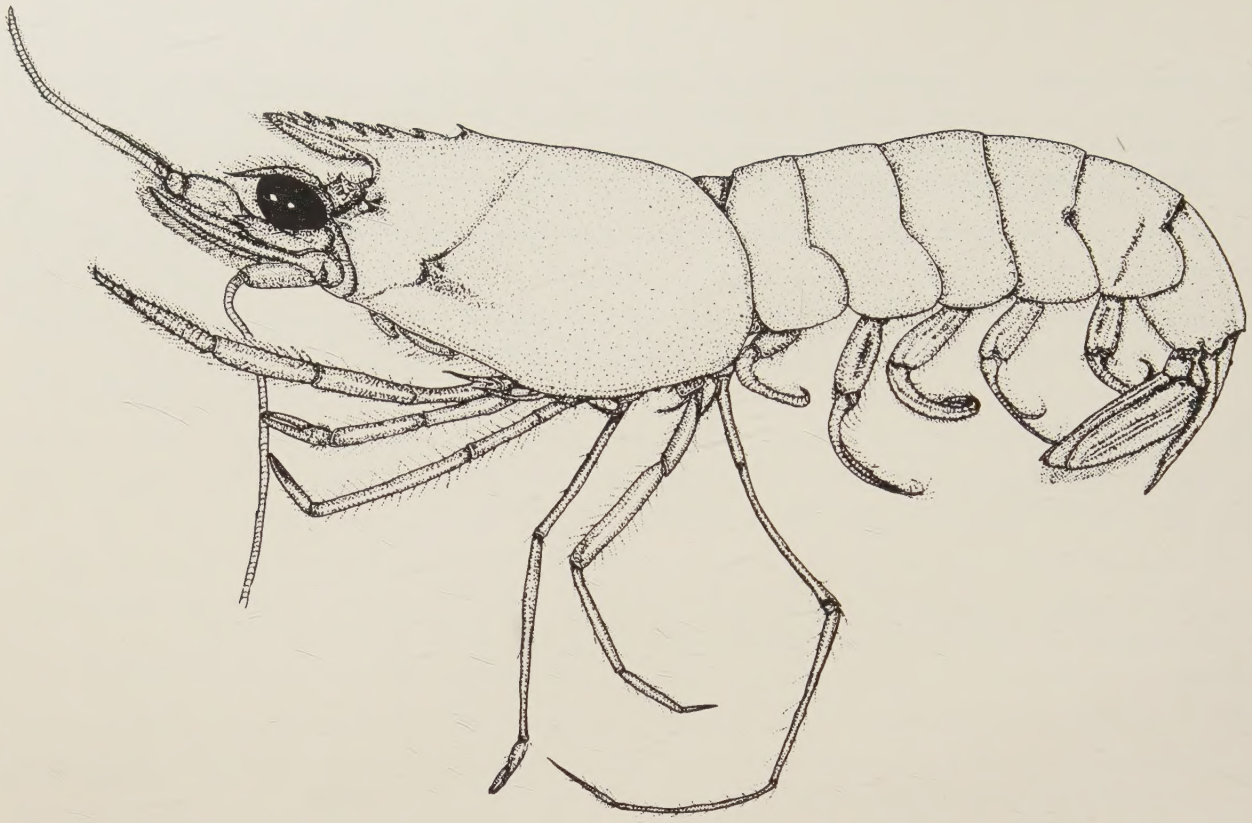


Figure 3. *Mesopenaeus tropicalis*: ♀, 17.1 mm CL, FSBC I 2065. Surface setae omitted.

9 November 1966; trawl; FSBC I 8962. — 1♀, 4.8; 6 February 1967; trawl; FSBC I 9118. — 1♀, 6.4; 1♀, damaged; 12 May 1967; trawl; FSBC I 8969. — 1♀, 14.7; 3 June 1967; trawl; FSBC I 8970. — 2 damaged, 2.7, 3.9; 2 August 1967; dredge; FSBC I 14583. — 1♂, 10.5; 3♀, 6.6-13.7; 2 damaged, 9.0, 10.0; 1 September 1967; trawl; FSBC I 8976. — 1♂, 9.9; 1♀, 11.1; 6 October 1967; trawl; FSBC I 8977. — 1♂, damaged; 6 October 1967; dredge; FSBC I 16624. — 1♂, 11.2; 4♀, 14.5-16.5; 3 November 1967; trawl; FSBC I 8979. — HOURGLASS STATION K: 1♀, 8.8; 22 July 1966; trawl; FSBC I 8961. — HOURGLASS STATION L: 1♀, 10.6; 13 January 1967; trawl; FSBC I 8963. — 1♀, 9.8; 7 June 1967; trawl; FSBC I 8971. — HOURGLASS STATION M: 1 damaged; 13 October 1965; trawl; stomach content; FSBC I 17294. — 1♀, approximately 45(TL); 13 November 1965; dredge; discard. — 3♀, 11.8-15.5; 14 December 1965; trawl; FSBC I 1465. — 3♀, 13.2-14.4; 14 January 1966; trawl; FSBC I 10035. — 1♂, 12.5; 1♀, 17.1; 15 February 1966; trawl; FBSC I 2065. — 1♂, 10.2; 2♀, 10.0, 11.9; 22 March 1966; trawl; FSBC I 2268. — 1♂, 9.6; 1 damaged; 12 April 1966; trawl; FSBC I 8960. — 6♀, 25-48(TL); 12 April 1966; dredge; discard. — 1♂, 11.6; 3♀, 12.5-14.3; 13 June 1966; trawl; FSBC I 3129. — 1 unsexed, 2.3; 5 September 1966; dredge; FSBC I 17283. — 1♂, 12.0; 3♀, 14.1-17.6; 7 December 1966; trawl; FSBC I 8659. — 1♂, 7.0; 10♀, 8.4-14.8; 1 damaged, 12.4; 31 January 1967; trawl; FSBC I 4801. — 1 damaged; 31 January 1967; trawl; stomach content; FSBC I 17295. — 5♀, 3.7-8.1; 9 March 1967; dredge; FSBC I 8966. — 1♀, 18.0; 8 April 1967; trawl; FSBC I 8967. — 1♂, 7.6; 1♀, 5.6; 8 April 1967; dredge; FSBC I 8968. — 1♂, 4.7; 7 June 1967; dredge; FSBC I 16623. — 4♂, 9.8-12.0; 4♀, 11.2-13.3; 6 July 1967; trawl; FSBC I 8972. — 2♂, 9.5, 10.3; 4♀, 5.6-14.5; 1 damaged, 6.2; 1 damaged; 6 July 1967; dredge; FSBC I 8973. — 2♂, 9.2, 10.4; 8♀, 8.1-12.6; 1♀, damaged; 1 damaged, 4.0; 1 damaged; 8 August 1967; trawl; FSBC I 8975. — 1♀, 14.0; 15 November 1967; trawl; FSBC I 8980.

Diagnosis: Rostrum short; epigastric tooth and first rostral tooth separated by about same distance as that between first and second rostral tooth. Orbital, postorbital, and antennal spines present; pterygostomian and branchiostegal spines absent. Ventral antennular flagellum conspicuously depressed (Pérez Farfante, 1977).

TABLE 2. *Mesopenaeus tropicalis*: MONTHLY OCCURRENCES AT HOURGLASS STATIONS. TRAWL CAPTURES (TOP NO.), DREDGE CAPTURES (BOTTOM NO.).

Mesopenaeus tropicalis

STA	1965					1966													1967											TOT
	A	S	O	N	D	J	F	M	A	M	J	J	J sp	A	S	O	N	D	J	J sp	F	M	A	M	J	J	A	S	O	N	
A																															
B_1							2														1									1 2
B_2																															
C_1																					1						2				3
C_2																															
D_1									4	1												1								2	2 6
D_2																															
E						5		4							1	6 2	2				1		2	1			2	6	2 1	5	34 6
I																															
J																															
K													1																		1
L																			1					1							2
M				1	3	3	2	3	2 6		4				1			4		12		5	1 2		1	8 8	13			1	56 24
TOT				1	3	8	4	7	2 10	1	4		1		2	6 2	2	4	1	12		6	1 2	2	2 1	8 8	15 2	6	2 1	8	100 37

Description: Pérez Farfante, 1977, pp. 333-338.

Geographic and bathymetric range: Northeast of Cape Lookout, North Carolina (34°33′N, 76°40′W) to the Straits of Florida and into the Gulf of Mexico to Alabama; Bahamas and through the Caribbean (including coasts of Central and South America); Atlantic coast of South America to Rio Grande do Sul, Brazil (34° S) (Pérez Farfante, 1977). Depth range 30 to 915 m (excluding questioned Hourglass records).

Remarks: One hundred thirty-seven *Mesopenaeus tropicalis* (2.3-18.0 mm CL) were caught during Hourglass sampling (Table 2); two additional specimens were examined from Hourglass fish stomachs. Specimens were most abundant at deepest stations E and M, 73 m (Figure 4); 88% were caught at this depth. Our data sheets show occurrence of three specimens at 6 and 18 m stations, but it is likely that errors involving transposition of field collection numbers were responsible for this apparent extension of depth range.

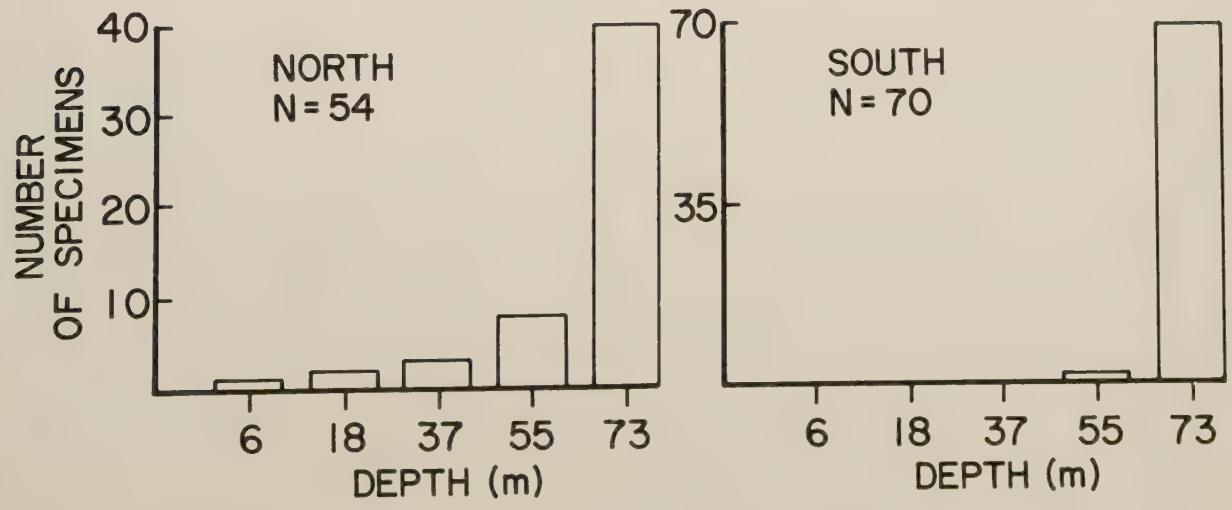


Figure 4. *Mesopenaeus tropicalis*: Abundance at stations on north and south transects during regular sampling.

Mesopenaeus tropicalis has an apparent discontinuous distribution in the Gulf of Mexico between Mississippi and Cabo Catoche, Yucatán. Pérez Farfante (1977) attributed this gap to inadequate sampling in this region. However, Brusher et al. (1972: Fig. 1) sampled 10 transects between Mississippi and Mexico in depths to 110 m; *M. tropicalis* was not captured during two years of sampling and may be absent in the northwestern Gulf.

During Hourglass sampling this species was found in salinity and temperature ranges of 33.00-36.00‰ and 13.9-25.6°C.

Crushed shell, dead bryozoans and calcareous algae particles were the substrates at Stations E and M. Springer and Bullis (1956) captured specimens in the northeast Gulf of Mexico (64-298 m) associated with bottoms characterized as coral, gravel, sand, mud, green and gray mud and sand, sponge. They found *M. tropicalis* near Tortugas over green clay and mud. Hence, no definitive substrate affinity was revealed.

No distinct seasonal abundance patterns were evident in a comparison between transects (Figure 5). Months of abundance on one transect tended to be months of low or non-existent occurrences on the other

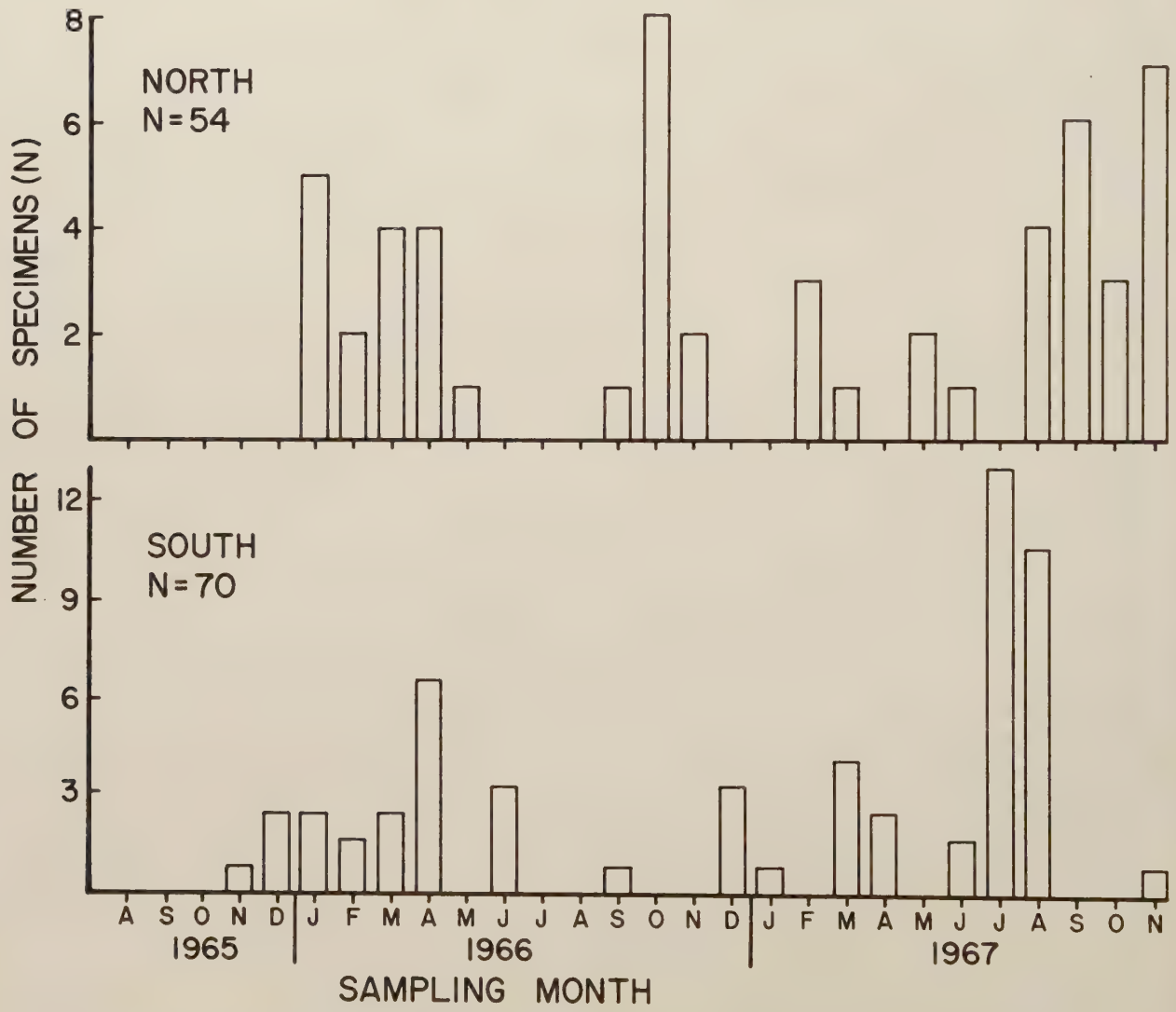


Figure 5. *Mesopenaeus tropicalis*: Intertransect monthly abundance during regular sampling.

transect. Combining catches from each transect produced a pattern of higher abundance during June through October.

No specimens were captured in day trawls, but diurnal sampling was conducted only on the northern transect and at stations where this species would not normally occur. Diel sampling in areas of high occurrence would probably reveal, as our diet analysis indicated, that this is a chiefly nocturnal species.

Dredging, which accounted for 22% of all specimens caught during regular sampling (Table 2), was much more successful at Station M (35% of catch) than at Station E (2% of catch).

Monthly size frequency analysis was accomplished with 110 animals caught during the last 24 sampling months (Figure 6). No distinct temporal progression of modal length was evident, probably because of small sample numbers in many months. Small specimens (<4 mm CL) were caught in March, August, September and November. Larger shrimp (mostly females) were caught from October through December, but the largest specimen was caught in April. As with other Hourglass penaeoids, especially those abundant on the southern transect, year-round recruitment is probably reflected in this length frequency analysis.

Sex ratio heavily favored females. Overall ratio for male/female was 0.27. The highest ratio (0.61) occurred for specimens less than 11.4 mm CL. Females dominated larger size classes; 34% of females were larger than the largest male, possibly reflecting a lower female mortality rate as well as a greater growth rate.

Reproductive analysis was not done because it was undesirable to excise ovaries and damage the relatively few individuals caught during Hourglass sampling.

TABLE 3. *Mesopenaeus tropicalis*: FOOD ITEM CONTENT AND COMPOSITION IN 25 STOMACHS.

Item	Predominant		Residual		Total	
	N	%*	N	%*	N	%*
Bryozoa	0	—	2	10	2	10
Foraminiferida	0	—	2	10	2	10
Polychaeta	4	19	0	—	4	19
Mollusca						
Unidentifiable fragments	1	5	2	10	3	15
Bivalvia	1	5	3	14	4	19
Gastropoda	0	—	1	5	1	5
Crustacea						
Unidentifiable fragments	9	43	0	—	9	43
Amphipoda	6	29	0	—	6	29
Isopoda	3	14	0	—	3	14
Decapoda						
Unidentifiable fragments	3	14	0	—	3	14
Caridea	2	10	0	—	2	10
Anomura (*Munida*)	1	5	0	—	1	5
Empty					4	16**

*Percent of stomachs (21) containing food.

**Percent of stomachs (25) examined.

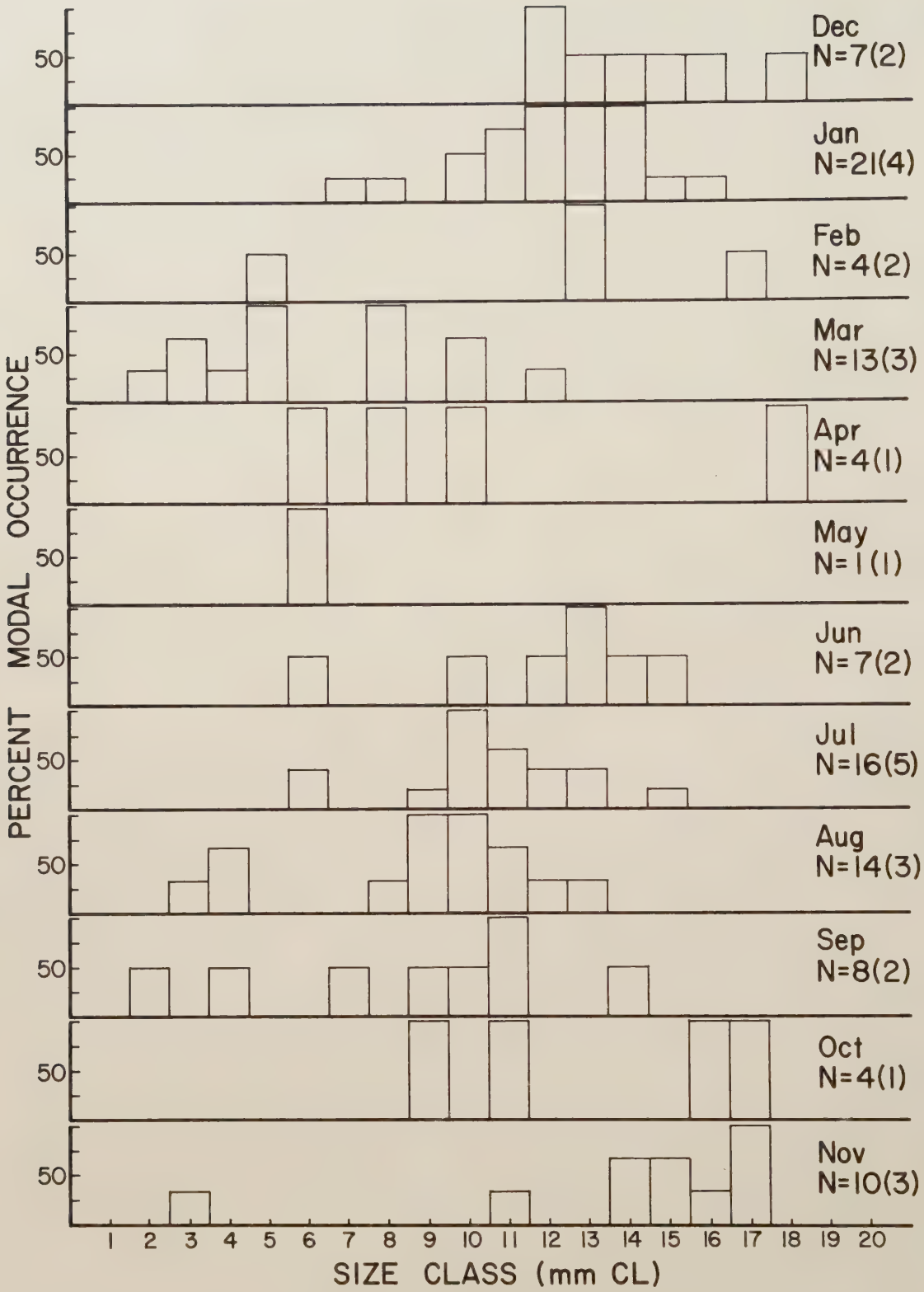


Figure 6. *Mæsopenaeus tropicalis*: Combined monthly length frequencies for last 24 sampling months. 1 mm CL size classes, total N (modal N).

Stomach contents of 25 specimens (9.9-16.8 mm CL) from night sampling (Stations E, November; M, January, July, December) were examined. Most stomachs (15) were 100% full, and only four were empty. Crustaceans dominated the diet of this shrimp, amphipods representing the most often identifiable order (Table 3). *Mesopenaeus tropicalis* was one of few Hourglass penaeoids with recognizable bryozoans in its stomach. Stomachs generally contained only one or two items, suggesting a selective feeding pattern. This species appears to be a benthic carnivore.

Two *M. tropicalis*, both damaged, were examined from stomachs of two female *Scorpaena agassizi* Goode and Bean (59, 126 mm standard length, SL) captured at Station M.

Genus *Solenocera* Lucas, 1849

Solenocera atlantidis Burkenroad, 1939

Figure 7

Solenocera siphonocera Smith, 1885, p. 186 [part], [not *Solenocera siphonocera* (Phillippi, 1840)].
Solenocera vioscai Burkenroad, 1934 b, p. 65 [part].
Solenocera atlantidis Burkenroad, 1939, pp. 10-13, figs. 5-10; Lindner and Anderson, 1941, pp. 183-187; Anderson and Lindner, 1945, p. 287; Hildebrand, 1955, p. 190; Voss, 1955, p. 9, fig. 4; Springer and Bullis, 1956, p. 8; Eldred, 1959, p. 5; Hulings, 1961, p. 217; Renfro and Brusher, 1963, p. 15; Bullis and Thompson, 1965, p. 7; Eldred et al., 1965, pp. 3, 39; Williams, 1965, pp. 14, 15, fig. 5; Joyce and Eldred, 1966, p. 26; Roberts and Pequegnat, 1970, p. 27; Subrahmanyam, 1971a, pp. 256, 257; 1971b, p. 317; Brusher et al., 1972, pp. 75, 78-81, 83, 86; Pérez Farfante and Bullis, 1973, pp. 20-26, figs. 11-14, 18, 19.

Material examined: HOURGLASS STATION A: 1♀, damaged; 1 damaged; 5 February 1967; dredge; FSBC I 8648. — HOURGLASS STATION B: 1♂, 40(TL); 8 November 1965; trawl; discard. — 2♀, 8.2, 10.9; 3 January 1966; trawl; FSBC I 1538. — 4♂, 10.8-13.2; 2♂, damaged; 7 February 1966; trawl; FSBC I 8867. — 1♂, 27(TL); 4♀, 23-42(TL); 18 July 1966; trawl; discard. — 1♂, 3.5; 18 October 1966; dredge; FSBC I 16655. — HOURGLASS STATION C: 1♀, damaged; 1 damaged; 3 August 1965; trawl; stomach content; FSBC I 16666. — 2♀, 9.7, 14.7; 31 August 1965; trawl; FSBC I 844. — 2♂, 8.4, 8.6; 3♀, 8.7-13.4; 8 November 1965; trawl; FSBC I 1132. — 1 damaged, 45(TL); 3 January 1966; trawl; discard. — 8♂, 6.4-8.6; 14♀, 10.0-14.5; 1♀, damaged; 3 March 1966; trawl; FSBC I 2203. — 1♀, 13.2; 2 May 1966; trawl; FSBC I 8868. — 1♀, 5.0; 6 June 1966; trawl; FSBC I 16654. — 1♂, 31(TL); 1♀, 40(TL); 6 June 1966; trawl; discard. — 3♂, 3.9-5.3; 4♀, 4.0-5.9; 2♀, damaged; 2 July 1966; trawl; FSBC I 16647. — 2♂, 32, 33(TL); 6♀, 29-45(TL); 2 July 1966; trawl; discard. — 1♂, 6.8; 1♀, 5.0; 2 July 1966; dredge; FSBC I 8871. — 2♂, 6.6, 7.3; 19♀, 8.8-16.6; 2♀, damaged; 18 July 1966; trawl; FSBC I 3345. — 1♂, 6.5; 1 August 1966; trawl; FSBC I 8874. — 5♂, 23-34(TL); 14♀, 24-46(TL); 1 August 1966; trawl; discard. — 1♂, 22(TL); 1 August 1966; dredge; discard. — 5♂, 6.1-8.3; 14♀, 5.5-11.7; 31 August 1966; trawl; FSBC I 3955. — 1♀, 11.5; 6 November 1966; trawl; FSBC I 8880. — 1♀, 9.6; 19 November 1966; trawl; FSBC I 8883. — 1♂, 6.4; 6 January 1967; trawl; FSBC I 8660. — 1♂, 9.0; 6 January 1967; trawl; stomach content; FSBC I 16667. — 4♀, 11.6-14.6; 25 January 1967; trawl; FSBC I 8894. — 2♀, 10.0, 13.3; 5 February 1967; trawl; FSBC I 8899. — 4♀, 12.9-16.0; 3 April 1967; trawl; FSBC I 8908. — 2♂, 11.4, 15.2; 1♂, damaged; 11 May 1967; trawl; FSBC I 8911. — 1♂, 6.7; 1♂, damaged; 1♀, 15.8; 2 June 1967; trawl; FSBC I 8914. — 1♀, 8.5; 2 June 1967; dredge; FSBC I 8915. — 1♀, 15.6; 1 July 1967; trawl; FSBC I 8922. — 1♀, damaged; 11 July 1967; dredge; FSBC I 13567. — 5♂, 3.4-7.0; 4♂, damaged; 9♀, 2.8-15.8; 1 damaged, 8.4; 3 damaged; 1 August 1967; trawl; FSBC I 8928. — 1♂, 5.9; 11 August 1967; trawl; FSBC I 8934. — 1♂, 5.8; 3♀, 4.3-14.0; 1♀, damaged; 31 August 1967; trawl; FSBC I 8935. — 3♂, 3.4-5.7; 7♀, 8.3-15.7; 5 October 1967; trawl; FSBC I 8944. — 2♂, 8.4, 13.3; 5 October 1967; dredge; FSBC I 8945. — 1♂, 8.6; 13♀, 8.7-14.6; 2 November 1967; trawl; FSBC I 8951. — HOURGLASS STATION D: 4♀, 42-55(TL); 4 January 1966; trawl; discard. — 4♂, 5.5-9.0; 11♀, 6.7-13.9; 4 March 1966; trawl; FSBC I 2213. — 1♂, 27(TL); 2♀, 30, 40(TL); 7 April 1966; trawl; discard. — 2♀, 22, 30(TL); 7 April 1966;

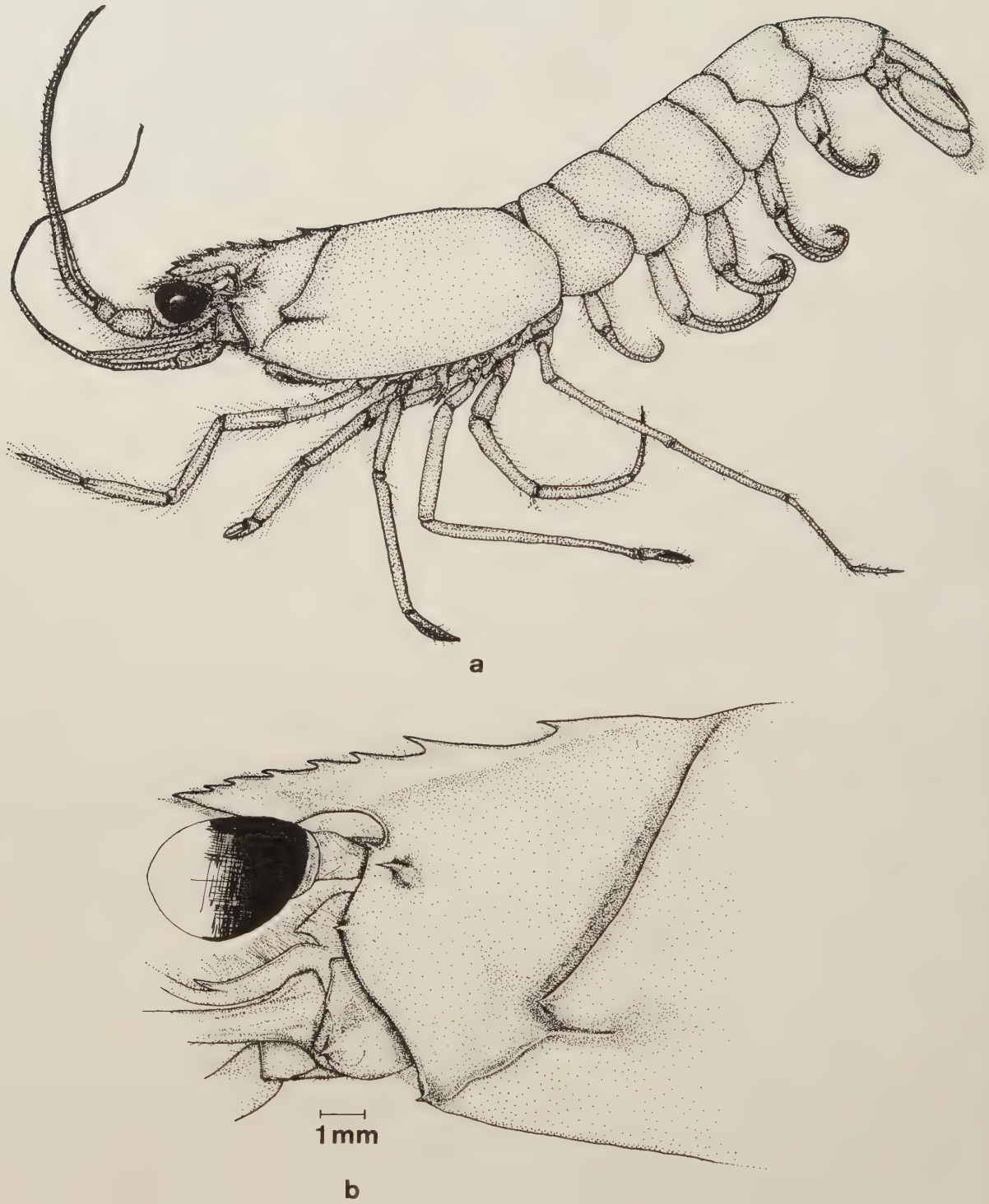


Figure 7. *Solenocera atlantidis*: a. ♀, 14.5 mm CL, FSBC I 16776; b. ♀, 15.1 mm CL, detail of head, FSBC I 785. Surface setae omitted.

dredge; discard. — 1♀, damaged; 7 April 1966; trawl; stomach content; FSBC I 17304. — 1♀, 46(TL); 7 June 1966; trawl; discard. — 1♀, 10.1; 3 July 1966; trawl; FSBC I 8872. — 3♀, 33-55(TL); 19 July 1966; trawl; discard. — 1♂, 5.2; 1♀, damaged; 1 damaged; 2 August 1966; dredge; FSBC I 8875. — 11♂, 3.6-8.0; 24♀, 2.8-10.8; 4 damaged; 1 September 1966; trawl; FSBC I 3989. — 1♂, 29(TL); 1 September 1966; dredge; discard. — 1♀, 6.4; 9 September 1966; trawl; FSBC I 8878. — 5♂, 5.3-8.7; 2♀, 6.0, 7.5; 9 October 1966; FSBC I 15289. — 2♂, 7.1, 7.4; 9 November 1966; trawl; FSBC I 8881. — 1♂, 8.4; 2 December 1966; trawl; FSBC I 8884. — 1 unsexed, 1.8; 2 December 1966; trawl; stomach content; FSBC I 16669. — 1♂, damaged; 1♀, 12.1; 1 damaged, 5.5; 26 January 1967; trawl; FSBC I 8895. — 1♀, 3.4; 26 January 1967; trawl; stomach content; FSBC I 17293. — 1 damaged, 5.5; 6 February 1967; dredge; FSBC I 16646. — 1♂, 8.1; 1♀, 5.5; 3 March 1967; dredge; FSBC I 8904. — 1♀, 11.3; 15 March 1967; trawl; FSBC I 8907. — 3♀, 9.7-15.4; 4 April 1967; trawl; FSBC I 8909. — 4♂, 3.7-6.0; 4♀, 5.3-11.8; 1♀, damaged; 12 May 1967; trawl; FSBC I 8912. — 6♀, 6.5-11.6; 1 damaged, 2.8; 3 June 1967; trawl; FSBC I 8916. — 1♂, 8.2; 1♀, 13.2; 3 June 1967; dredge; FSBC I 8917. — 5♀, 6.7-10.4; 1 damaged; 2 July 1967; trawl; FSBC I 8923. — 1♀, 8.7; 2 August 1967; dredge; FSBC I 8929. — 1♂, 7.9; 4♀, 4.9-13.4; 2♀, damaged; 1 damaged, 5.1; 1 September 1967; trawl; FSBC I 8936. — 2♀, 9.6, 10.0; 1 September 1967; dredge; FSBC I 8937. — 1♀, 12.5; 6 October 1967; trawl; FSBC I 8946. — 8♂, 6.7-9.1; 11♀, 5.7-13.9; 1♀, damaged; 4 damaged, 7.4-9.8; 3 November 1967; trawl; FSBC I 8952. — HOURGLASS STATION E: 2♀, 8.9, 11.0; 9 November 1965; trawl; FSBC I 1142. — 1♀, 8.5; 4 January 1966; trawl; FSBC I 2002. — 1♂, 3.4; 1♀, 12.5; 8 February 1966; dredge; FSBC I 17280. — 1♀, 18(TL); 8 February 1966; dredge; discard. — 1♂, 3.7; 7 April 1966; trawl; stomach content; FSBC I 17291. — 1♀, damaged; 1 damaged; 19 July 1966; trawl; FSBC I 16650. — 1♀, 12.4; 19 July 1966; trawl; stomach content; FSBC I 16670. — 1 damaged; 2 August 1966; dredge; FSBC I 16651. — 1♂, damaged; 1 September 1966; dredge; FSBC I 16648. — 2♂, 5.5, 8.8; 9 October 1966; trawl; FSBC I 15290. — 1 damaged, 9 October 1966; dredge; FSBC I 17279. — 1♂, 4.5; 1♀, 11.7; 2 December 1966; trawl; FSBC I 8885. — 1♂, damaged; 4♀, 1.8-2.8; 1♀, damaged; 4 damaged, 1.9-3.3; 2 December 1966; dredge; FSBC I 17282. — 2♂, 7.4, 8.1; 2♀, 9.7, 14.8; 3 March 1967; trawl; FSBC I 8905. — 1♀, damaged; 12 May 1967; trawl; FSBC I 16645. — 1 damaged; 3 June 1967; trawl; stomach content; FSBC I 17292. — 1♂, 9.1; 2 August 1967; trawl; FSBC I 8930. — 1♀, damaged; 1 unsexed, 1.8; 2 August 1967; dredge; FSBC I 14203. — 1♂, 5.8; 1♂, damaged; 2♀, 8.9, 10.6; 3♀, damaged; 1 damaged, 12.0; 1 September 1967; trawl; FSBC I 8938. — 3♂, 5.7-9.2; 1♀, 8.0; 6 October 1967; trawl; FSBC I 8947. — 2♂, 5.0, 7.9; 8♀, 5.9-11.3; 1 unsexed, 1.8; 1 damaged, 2.1; 2 damaged; 3 November 1967; trawl; FSBC I 8953. — HOURGLASS STATION J: 1♂, 7.5; 2♀, 10.2, 11.2; 13 January 1966; trawl; FSBC I 8865. — 4♀, 11.8-13.3; 1♀, damaged; 30 January 1967; trawl; FSBC I 8896. — 3♂, 6.9-8.9; 1♀, 8.8; 14 November 1967; dredge; FSBC I 8954. — HOURGLASS STATION K: 1♂, 7.1; 5♀, 7.5-15.3; 6 August 1965; trawl; FSBC I 785. — 1♀, 48(TL); 2 damaged; 13 October 1965; trawl; discard. — 7♂, 6.2-8.0; 15♀, 6.5-15.3; 1♀, damaged; 12 November 1965; trawl; FSBC I 1999. — 2♀, 9.1, 13.3; 13 January 1966; trawl; FSBC I 8866. — 1♂, 43(TL); 14 February 1966; trawl; discard. — 4♂, 8.4-9.3; 21♀, 10.1-16.0; 1♀, damaged; 2 damaged; 21 March 1966; trawl; FSBC I 2259. — 1 damaged, 4.4; 11 April 1966; trawl; FSBC I 13508. — 8♂, 28-39(TL); 44♀, 36-56(TL); 11 April 1966; trawl; discard. — 1♀, 37(TL); 11 April 1966; dredge; discard. — 1♀, 48(TL); 11 May 1966; trawl; discard. — 1♂, damaged; 12 June 1966; trawl; FSBC I 6919. — 2♀, 52, 58(TL); 12 June 1966; trawl; discard. — 2♂, 28, 32(TL); 5♀, 33-57(TL); 5 July 1966; trawl; discard. — 10♀, 6.7-11.9; 4 damaged, 7.9-12.1; 22 July 1966; trawl; FSBC I 8873. — 12♂, 24-34(TL); 19♀, 29-43(TL); 5 August 1966; trawl; discard. — 4♀, 22-41(TL); 5 August 1966; dredge; discard. — 3♂, 25-29(TL); 11♀, 34-47(TL); 4 September 1966; trawl; discard. — 1♀, 11.5; 6 December 1966; trawl; FSBC I 8886. — 1♀, 14.0; 12 January 1967; trawl; stomach content; FSBC I 16668. — 2♂, 7.6, 8.9; 6♀, 8.7-15.2; 5 damaged; 30 January 1967; trawl; FSBC I 8897. — 1♂, damaged; 1♀, 13.4; 1 damaged, 6.8; 15 February 1967; trawl; FSBC I 8900. — 3♂, 6.7-8.9; 2♀, 11.3, 11.7; 6 June 1967; trawl; FSBC I 8918. — 3♂, 6.4-9.0; 3♀, 6.9-11.6; 6 June 1967; dredge; FSBC I 8919. — 1♀, 12.1; 5 July 1967; trawl; FSBC I 8924. — 1♂, 6.9; 5 July 1967; dredge; FSBC I 8925. — 2♂, 2.9, 7.6; 4♀, 3.6-15.1; 7 August 1967; trawl; FSBC I 8931. — 1♂, 9.6; 1♀, 11.6; 4 September 1967; trawl; FSBC I 8939. — 1♀, 8.4; 4 September 1967; dredge; FSBC I 8940. — 1♂, 7.1; 10♀, 6.0-13.2; 11 October

1967; trawl; FSBC I 8948. — 1♀, 8.9; 14 November 1967; trawl; FSBC I 8955. — HOURGLASS STATION L: 1♂, 3.0; 13 November 1965; trawl; FSBC I 8079. — 6♀, 12.9-14.9; 13 December 1965; trawl; FSBC I 1453. — 1♂, 54(TL); 15 February 1966; trawl; discard. — 1♀, 53(TL); 15 February 1966; dredge; discard. — 1♀, 52(TL); 22 March 1966; trawl; discard. — 1♀, 52(TL); 12 April 1966; trawl; discard. — 1♂, 8.8; 2♀, 11.5, 11.8; 1♀, damaged; 12 May 1966; trawl; FSBC I 8869. — 1♂, 32(TL); 3♀, 41-44(TL); 6 July 1966; trawl; discard. — 1♀, 40(TL); 22 July 1966; trawl; discard. — 2♂, 32, 41(TL); 2♀, 43, 47(TL); 6 August 1966; trawl; discard. — 2♀, 5.0, 5.6; 6 August 1966; trawl; FSBC I 8876. — 1 damaged; 5 September 1966; trawl; FSBC I 16644. — 2♂, 24, 29(TL); 9♀, 28-62(TL); 5 September 1966; trawl; discard. — 1♂, 4.8; 1♂, damaged; 2♀, 4.0, 4.4; 1 damaged; 5 September 1966; dredge; FSBC I 17281. — 2♂, 7.5, 7.6; 1♀, damaged; 13 October 1966; trawl; FSBC I 6716. — 1 damaged, 3.4; 1 damaged; 13 October 1966; dredge; FSBC I 8879. — 1♂, 6.1; 13 November 1966; dredge; FSBC I 8882. — 1♀, 9.1; 7 December 1966; dredge; FSBC I 8887. — 4♀, 6.0-13.8; 13 January 1967; trawl; FSBC I 8890. — 1♀, 10.7; 13 January 1967; dredge; FSBC I 8891. — 3♀, 10.3-15.0; 31 January 1967; trawl; FSBC I 8898. — 1♀, 2.5; 31 January 1967; trawl; stomach content; FSBC I 17288. — 1♀, 13.6; 16 February 1967; trawl; FSBC I 8901. — 1♀, 5.2; 16 February 1967; dredge; FSBC I 8902. — 1♀, 13.2; 9 March 1967; trawl; FSBC I 8906. — 1♀, 8.4; 8 April 1967; dredge; FSBC I 8910. — 1♀, 12.8; 16 May 1967; dredge; FSBC I 8913. — 1♂, 3.0; 3♀, 13.5-16.0; 7 June 1967; trawl; FSBC I 8920. — 1♂, 7.1; 6 July 1967; trawl; FSBC I 8926. — 1♂, 8.9; 1♀, 14.8; 6 July 1967; dredge; FSBC I 8927. — 1♂, 3.9; 5♀, 4.9-13.9; 2 damaged, 3.0, 4.5; 4 damaged; 8 August 1967; trawl; FSBC I 8932. — 2♂, damaged; 2♀, 2.5, 2.7; 2 damaged; 8 August 1967; dredge; FSBC I 14580. — 2♂, 5.8, 6.9; 1♂, damaged; 2♀, 7.3, 8.4; 5 September 1967; trawl; FSBC I 8941. — 1♀, 13.1; 5 September 1967; dredge; FSBC I 8942. — 1♀, 13.1; 12 October 1967; dredge; FSBC I 8949. — 5♂, 6.5-9.2; 6♀, 5.7-10.5; 1 unsexed, 2.4; 2 damaged; 15 November 1967; trawl; FSBC I 8956. — 1♂, 4.8; 3♀, 7.0-7.6; 2 unsexed, 2.7, 2.8; 15 November 1967; dredge; FSBC I 8957. — HOURGLASS STATION M: 1♂, 7.1; 13 October 1965; trawl; stomach content; FSBC I 17289. — 1♀, 11.2; 14 December 1965; trawl; FSBC I 1466. — 1♂, 35(TL); 15 February 1966; trawl; discard. — 1♀, 6.3; 13 June 1966; trawl; FSBC I 8870. — 1♀, 44(TL); 6 July 1966; trawl; discard. — 2♂, 3.0, 4.0; 1 damaged, 3.5; 1 damaged; 6 July 1966; dredge; FSBC I 16649. — 8♂, 3.2-11.0; 9♀, 3.5-6.0; 1♀, damaged; 1 damaged; 6 August 1966; trawl; FSBC I 8877. — 1♀, damaged; 6 August 1966; dredge; FSBC I 16652. — 1♀, 35(TL); 6 August 1966; dredge; discard. — 1♀, 38(TL); 5 September 1966; trawl; discard. — 2♂, damaged; 1 damaged, 2.5; 5 September 1966; dredge; FSBC I 17278. — 1♂, 3.3; 3♀, 13.4-14.0; 7 December 1966; trawl; FSBC I 8888. — 1♀, 8.4; 7 December 1966; dredge; FSBC I 8889. — 1♀, 9.9; 13 January 1967; trawl; FSBC I 8892. — 1♂, 6.1; 2♀, 3.2, 5.0; 1 damaged; 13 January 1967; dredge; FSBC I 8893. — 1♂, damaged; 1 damaged; 31 January 1967; trawl; stomach content; FSBC I 17290. — 5♀, 4.0-10.6; 1♀, damaged; 16 February 1967; trawl; FSBC I 8903. — 1♀, 2.5; 1 damaged, 2.3; 9 March 1967; dredge; FSBC I 13540. — 1 damaged, 3.5; 8 April 1967; dredge; FSBC I 16653. — 1♂, 6.5; 7 June 1967; trawl; FSBC I 8921. — 1♂, 3.2; 1 damaged, 4.5; 6 July 1967; trawl; FSBC I 13549. — 1♂, 8.0; 8 August 1967; trawl; FSBC I 8933. — 3♂, 9.3-10.0; 6♀, 4.8-14.1; 1 damaged, 8.6; 5 September 1967; trawl; FSBC I 8943. — 1♂, 5.3; 1♂, damaged; 1♀, 14.1; 12 October 1967; trawl; FSBC I 8950.

Diagnosis: Rostral and epigastric teeth 4-7, usually 6. Anterior part of carapace with short setae; postrostral carina ending at level of cervical sulcus; pterygostomian spine with narrow base, dorsal margin joining carapace at about right angle. Prosartema extending, at most, to distal end of first antennular segment. Scaphocerite short, not exceeding antennular peduncle by more than 10% of its own length. Petasma with ventrolateral lobule lacking distal lamella, extending only to or slightly surpassing dorsomedian lobule. Thelycum with sternite XIII lacking anteromedian ridge, with posterior portion just ahead of fourth pereopods forming convex or pointed elevation; paired protuberances on sternite XIV widely separated, low, rounded to subconical (Pérez Farfante and Bullis, 1973).

Description: Pérez Farfante and Bullis, 1973, pp. 20-25.

TABLE 4. *Solenocera atlantidis*: MONTHLY OCCURRENCES AT HOURGLASS STATIONS. TRAWL CAPTURES (TOP NO.), DREDGE CAPTURES (BOTTOM NO.).

Solenocera atlantidis

STA	1965					1966												1967											TOT
	A	S	O	N	D	J	F	M	A	M	J	J	J sp	A	S	O	N	D	J	J sp	F	M	A	M	J	J	A	S	O	N	
A																															
B_1				1		2	6						5								2										2 14
B_2																1														2
C_1		2		5		1		23		1	3	17 2	23	20 1	19		1		1	4	2		4	3	3 1	1	1 22	5	10 2	14	184 6
C_2																	1										1				2 1
D_1						4		15	3 2		1	1	3	3	39 1	7	2	1		3	1	2	3	9	7 2	1 6	1	8 2	1	24	137 14
D_2															1							1									2
E				2		1	3						2	1	1	2 1		2 10				4		1			1 2	8	4	14	41 18
I																															
J						3														5										4	8 4
K	6		3	23		2	1	28	53 1	1	3	7	14	31 4	14			1		13	3				5 6	1 1	6	2 3	11	1	227 15
L				1	6		1 1	1	1	4		4	1	6	12 5	3 2	1	1	4 1	3	1 1	1		1	1	4	1 2	12 6	5 1	1	14 6	85 30
M					1		1				1	1 4		19 2	1 3			4 1	1 4		6	2	1		1	2	1	10	3		52 17
TOT	6	2	3	32	7	13	9 4	67	57 3	6	8	30 6	48	76 11	86 10	12 4	4 1	8 12	6 5	28	12 4	6 4	7 2	13 1	20 9	11 4	43 10	38 6	29 3	67 10	754 109

Geographic and bathymetric range: Oregon Inlet, North Carolina southward through Gulf of Mexico; West Indies; Caribbean coast of Central and South America; Atlantic coast of South America to Cananéia, Brazil (25°S) (Pérez Farfante and Bullis, 1973). Shallow oceanic waters to about 130 m; most common to 75 m. Williams (1965) gave depth range to 329 m, but subsequent studies (Roberts and Pequegnat, 1970; Pérez Farfante and Bullis, 1973) show that occurrences beyond 100 m are rare. We found no records of estuarine occurrence.

Remarks: Eight hundred sixty-three specimens (1.8-16.9 mm CL) were recovered from our sampling (Table 4); an additional 13 were found in fish stomachs. Depth distribution of *S. atlantidis* was similar along both transects. However, the difference in shrimp abundance at 37 and 55 m stations on the southern transects was much larger than the difference at comparable stations on the northern transect (Figure 8).

Solenocera atlantidis was found in salinities and temperatures ranging from 32.26 to 36.49 ‰ and 13.9 to 28.0°C. Eldred et al. (1965) and Hulings (1961) reported similar salinities (33.0 to 37.5 ‰).

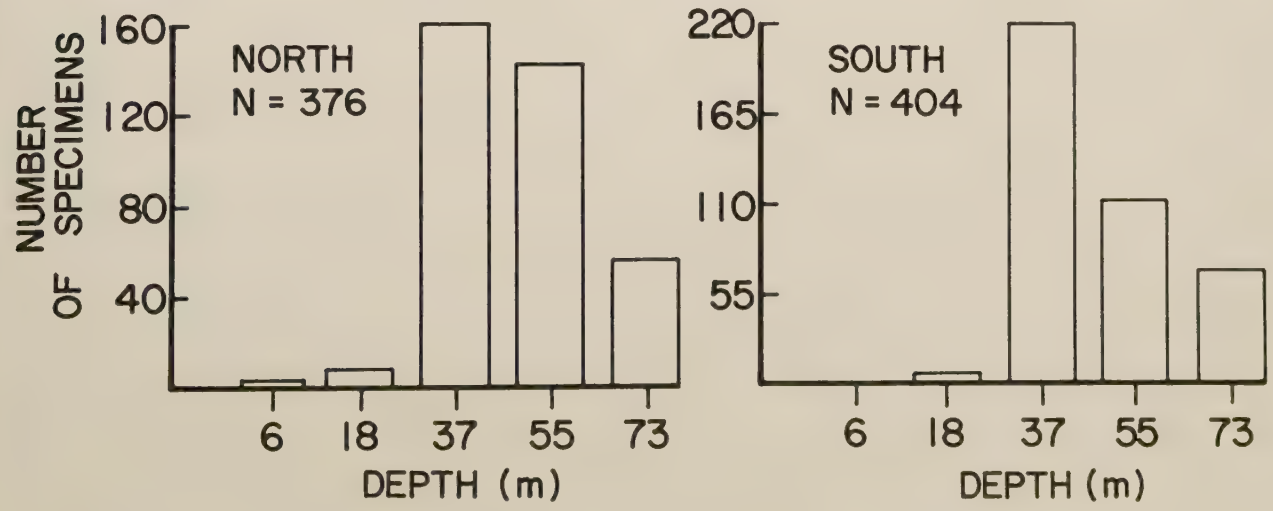


Figure 8. *Solenocera atlantidis*: Abundance at stations on north and south transects during regular sampling.

Substrates where Hourglass *S. atlantidis* was most abundant (Stations C, D, K, and L) consisted of quartz sand, shell sand, exposed limestone, calcium carbonate particles and calcareous silt. Pérez Farfante and Bullis (1973) listed the following substrates: mud, gray mud, green mud, sand, coral sand, white sand, fine white sand, shells, broken shell, coral, dark slate, black specks. Williams (1965) listed mud, shell, and coral bottoms.

Specimens were captured in our study area during each of the 28 months sampled. Intertransect temporal abundance was generally similar, with more numerous occurrences in March and April 1966, July through September 1966, and August through November 1967 (Figure 9).

Diurnal sampling was unproductive; only 7 of 311 specimens (2%) were caught in daylight.

Dredging accounted for 14% of *S. atlantidis* caught during regular sampling, and contributed a greater catch proportion on the southern transect and at stations of lower total abundance.

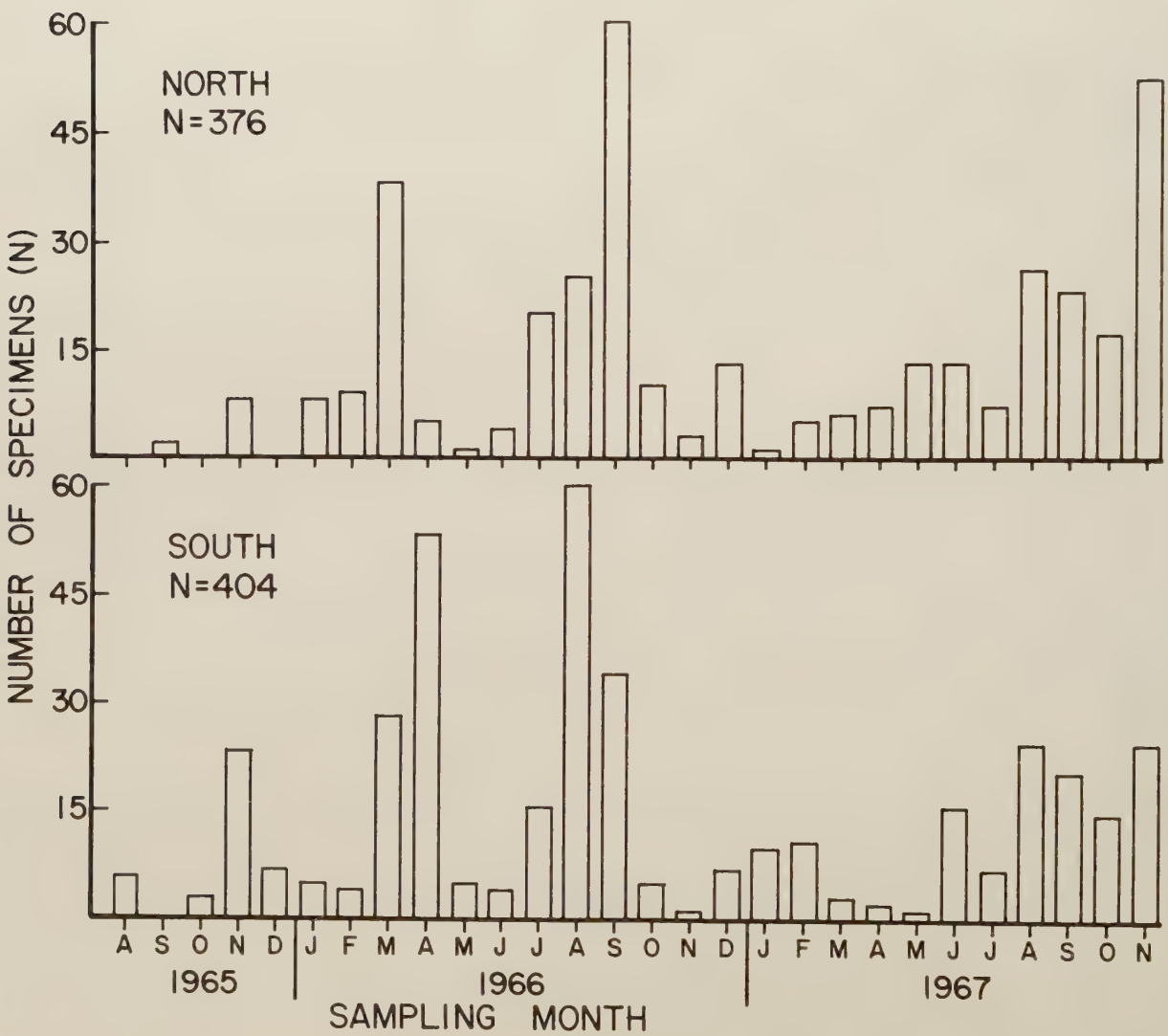


Figure 9. *Solenocera atlantidis*: Intertransect monthly abundance during regular sampling.

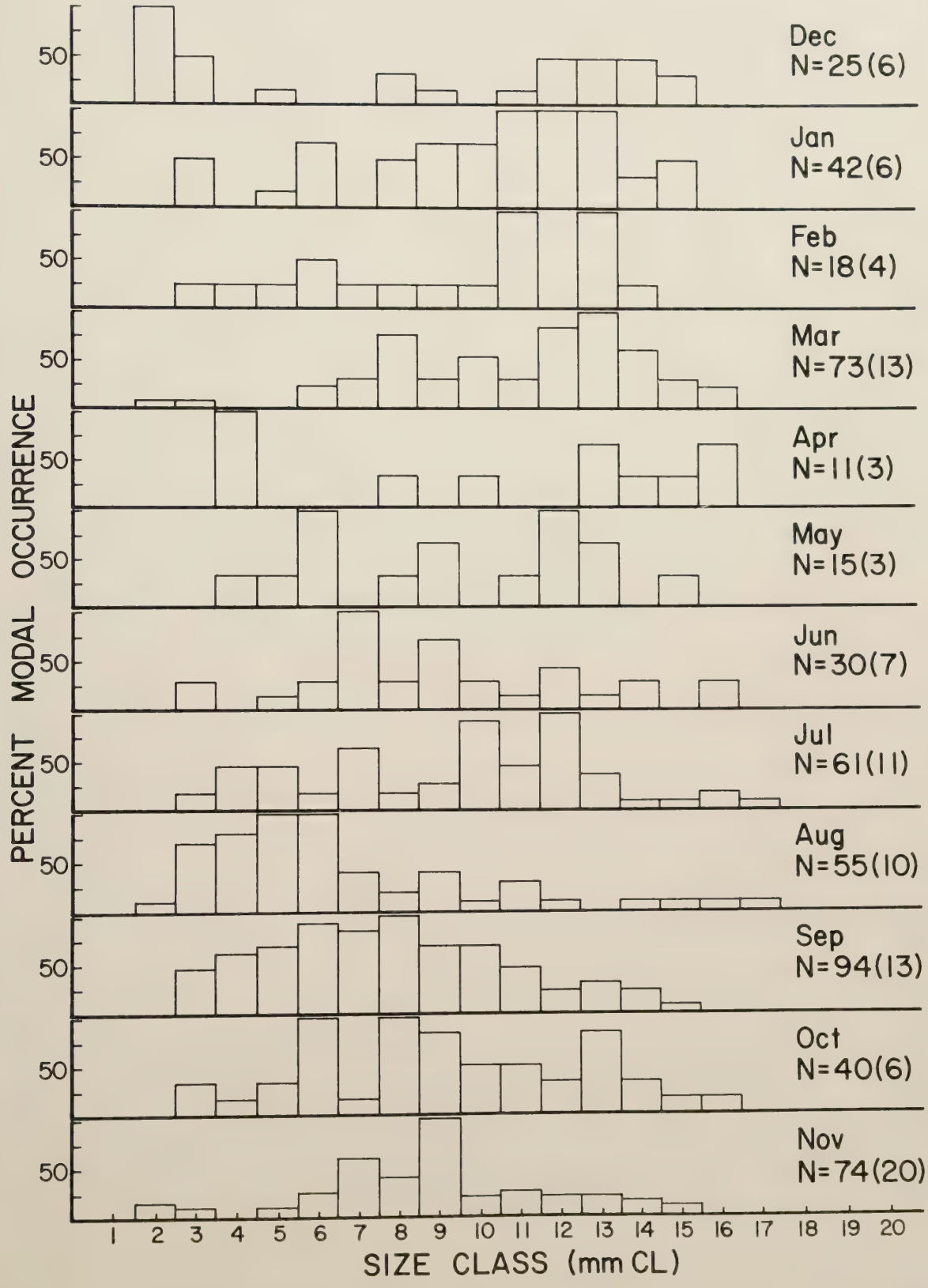


Figure 10. *Solenocera atlantidis*: Combined monthly length frequencies for last 24 sampling months. 1 mm CL size classes, total N (modal N).

Small specimens (<4.4 mm CL) were found year-round (Figure 10), indicating almost continuous recruitment. A modal progression of length frequency was evident in samples from August through November and continued less distinctly through March. Modal length increased from size class 5 and 6 to class 9 in November and class 13 in March, indicating growth of 1.0 to 1.1 mm CL per month. Apparent year-round recruitment and differential growth between sexes may have partially obscured modality.

Overall sex ratio (male /female) for the last 24 months, including discarded animals, was 0.39. Heegaard (1967) reported a similar ratio (0.31) for *Solenocera membranacea* (Risso, 1816) in the Mediterranean. We encountered no male larger than 11.0 mm CL, yet 60% of the females were larger than this. Females were found to be dominant at lengths up to 5.4 mm CL and greater than 8.5 mm CL (Figure 11). A cumulative ratio of 0.97 was maintained for shrimp less than 9.4 mm CL, but abruptly dropped for longer lengths.

Heegaard (1967) suggested protandrous hermaphrodism in *Soleneocera membranacea*. In a collection of specimens from commercial nets in four days of sampling, he found no animals shorter than 14 mm CL (measured from tip of supraorbital spine to posterior margin of the carapace), and only 2% of females as small as the largest male. He later (1972) stated that smaller males escaped through the net meshes. It would be difficult to conclude that *S. membranacea* was a hermaphrodite without examining material from smaller size classes taken over a greater length of time. Since he did not find transitionals (males with female characters), it was more likely that females simply outlived males.

Ovarian development was assessed for 364 females, including length frequencies for each development stage (Figure 12). Immature females were encountered to size class 12. No advanced stages were found in size classes 1 through 6; onset of sexual maturity was pronounced at about 8 mm CL.

Most males reached sexual maturity by 7.0 mm CL. Smallest mature male was 3.0 mm CL and largest immature male was 9.3 mm CL.

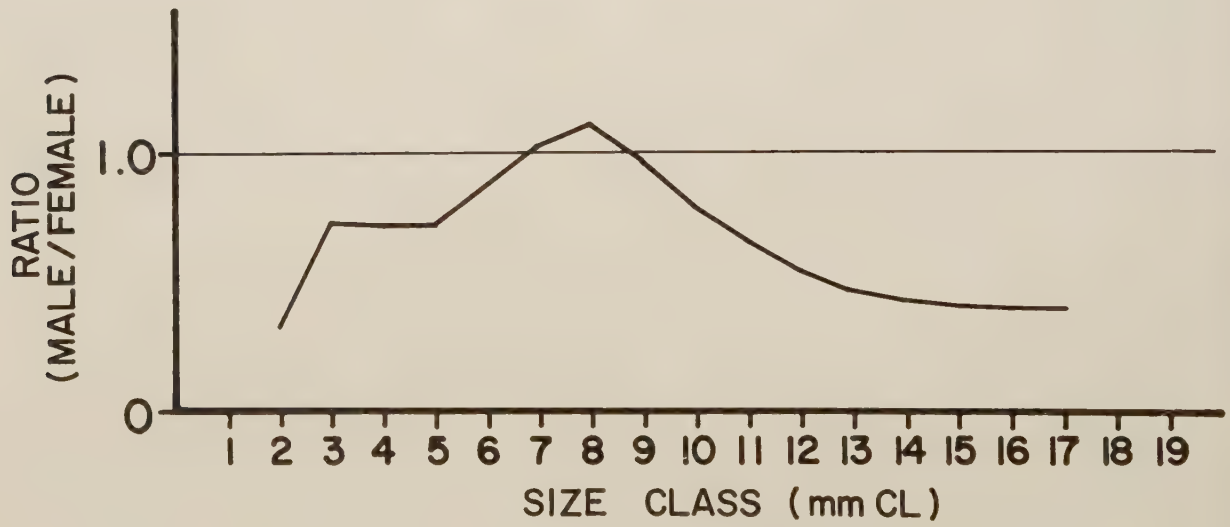


Figure 11. *Solenocera atlantidis*: Cumulative male/female ratio for last 24 sampling months. 1 mm CL size classes.

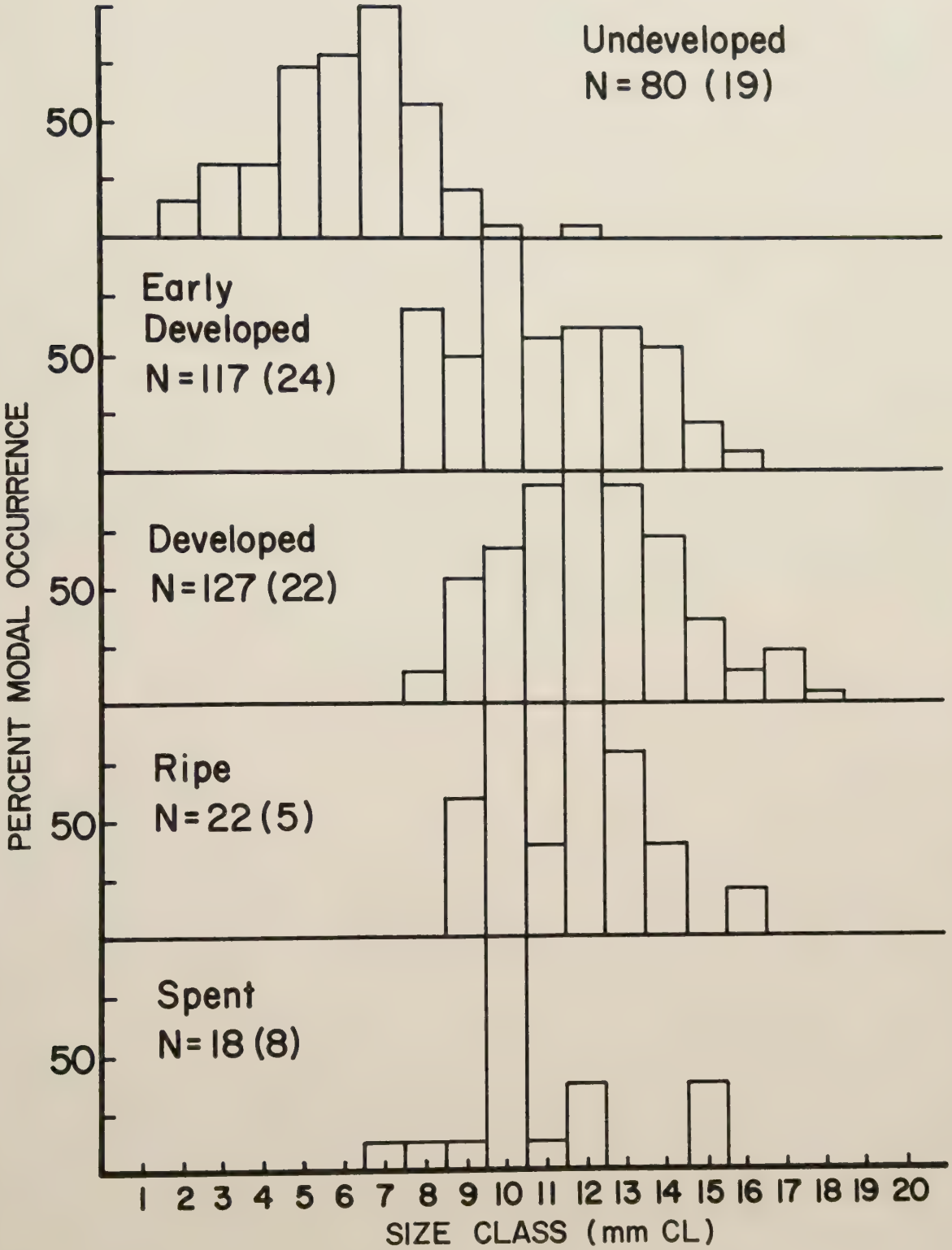


Figure 12. *Solenocera atlantidis*: Length frequencies for ovarian developmental stages. 1 mm size classes, total N (modal N).

Monthly distribution of ovarian developmental stages indicated almost year-round spawning (Figure 13). Ripe and spent females were encountered in all months except April, May and June, further supporting indications of year-round recruitment from length frequencies. Highest percentage of ripe and spent females occurred in February, in general agreement with Burkenroad (1939), who found well ripened ovaries in "nearly all females of all sizes" during March off Alabama.

Stomach contents of 25 specimens (11.4-16.9 mm CL) from night sampling (Stations K, March; L, December; C, July; D, September) were examined (Table 5). One stomach was empty, but all others were at least 50% full; most (16) were 100% full. Bivalves dominated over half of stomachs examined, possibly because of shell fragment durability. Foraminiferans were likewise found in over half the stomachs. No recognizable plant material was found in any stomach, suggesting that this shrimp is a generalized benthic carnivore.

Solenocera atlantidis was found in the stomachs of three different species of scorpion fish. Three females (2.5-14.0 mm CL) were found in three *Scorpaena brasiliensis* Cuvier (131-150 mm SL) at Stations E, J and L. Two males (3.7-7.1 mm CL) and three damaged specimens were found in four stomachs of *Scorpaena agassizi* (91-104 mm SL) at Stations E and M. One female (3.4 mm CL) and one unsexed specimen (1.8 mm CL) were examined from two *Scorpaena calcarata* Goode and Bean (46,107 mm SL) at Station D. A dusky flounder (210 mm SL), *Syacium papillosum* (Linné), captured at Station J had two damaged *S. atlantidis* in its stomach. One male (9.0 mm CL) was found in the stomach of a sand perch, *Diplectrum formosum* (Linné) (90 mm SL), captured at Station C.

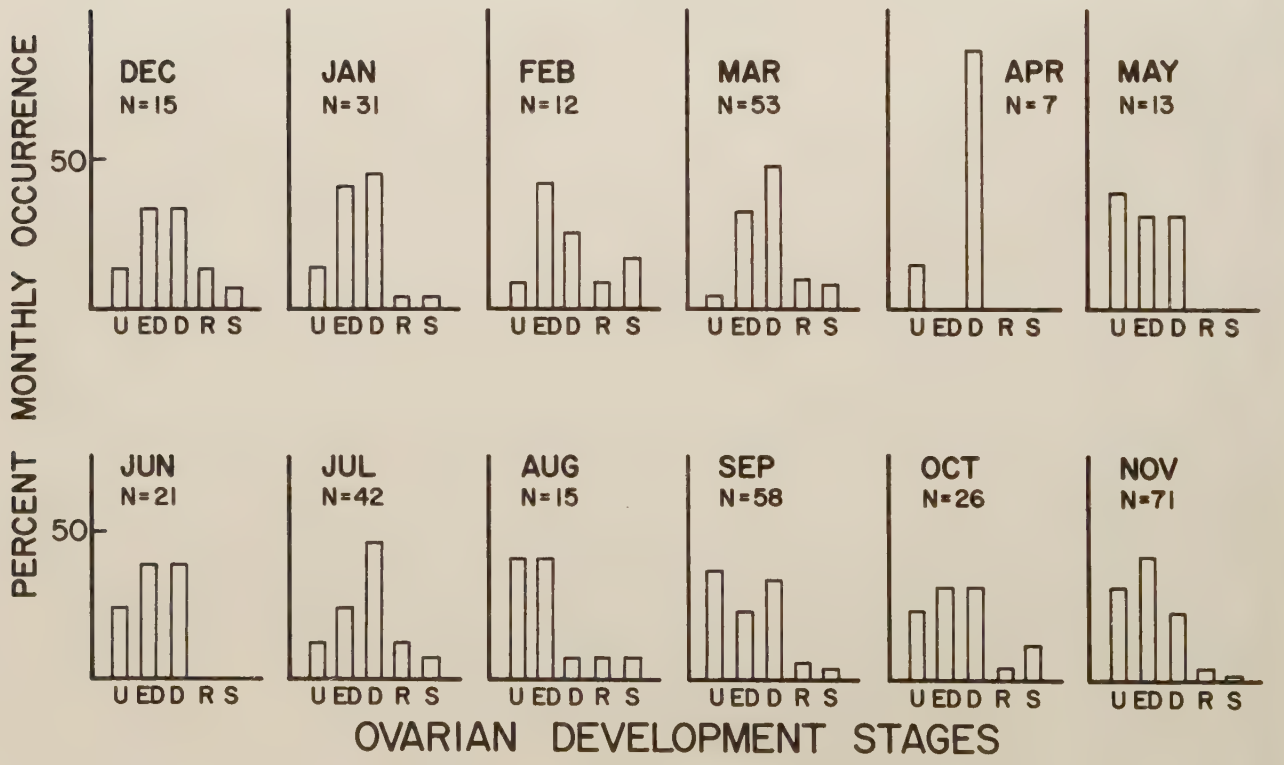


Figure 13. *Solenocera atlantidis*: Monthly distribution of ovarian developmental stages.

TABLE 5. *Solenocera atlantidis*: FOOD ITEM CONTENT AND COMPOSITION IN 25 STOMACHS.

Item	Predominant		Residual		Total	
	N	%*	N	%*	N	%*
Foraminiferida	0	—	14	58	14	58
Nematoda	0	—	1	4	1	4
Polychaeta	10	42	3	12	13	54
Mollusca						
Bivalvia	13	54	0	—	13	54
Gastropoda	6	25	4	17	10	42
Cephalopoda	1	4	0	—	1	4
Crustacea						
Unidentifiable fragments	9	38	2	8	11	45
Ostracoda	0	—	3	12	3	12
Amphipoda	2	8	0	—	2	8
Brachyura	1	4	0	—	1	4
Brachiopoda	0	—	1	4	1	4
Empty					1	4**

*Percent of stomachs (24) containing food.
**Percent of stomachs (25) examined.

Family Penaeidae Rafinesque, 1815
Genus *Metapenaeopsis* Bouvier, 1905

Metapenaeopsis goodei (Smith, 1885)

Figure 14

Parapenaeus goodei Smith, 1885, p. 176.
Archipenaeopsis vestitus Bouvier, 1905, p. 747.
Parapenaeopsis rathbuni Bouvier, 1905, p. 748.
Penaeopsis goodei: Bouvier, 1908, p. 6; Milne Edwards and Bouvier, 1909, pp. 226-228, fig. 55, pl. 4, figs. 6-10; Boone, 1930, pp. 110-112, pl. 34, [not text figs. 4A, B]; Wheeler, 1937, pp. 325, 332, 344; Voss, 1955, p. 11, fig. 20; Eldred, 1959, p. 5; Tabb and Manning, 1961, p. 595; Bullis and Thompson, 1965, p. 5; Eldred et al., 1965, p. 3; Williams, 1965, pp. 29, 30, figs. 16, 17A, B; Joyce and Eldred, 1966, p. 26; Rouse, 1969, p. 135.
Penaeopsis (Metapenaeopsis) goodei: Burkenroad, 1934a, pp. 15-17, 25, 28, figs. 2, 3; Anderson and Lindner, 1945, p. 310; Springer and Bullis, 1956, p. 9.
Metapenaeopsis goodei: Pérez Farfante, 1971, pp. 9-16, figs. 2-8, 13A; Chace, 1972, p. 7; Camp et al., 1977, pp. 23, 43, 46.

Material examined: HOURGLASS STATION B: 1♀, 10.8; 26 August 1965; trawl; FSBC I 819. — 2♂, 8.1, 9.8; 10♀, 9.3-12.4; 30 August 1965; trawl; FSBC I 833. — 1♀, damaged; 8 November 1965; trawl; FSBC I 16636. — 2♂, 44, 50(TL); 2♀, 49, 51(TL); 8 November 1965; trawl; discard. — 1♂, 38(TL); 3♀, 43-57(TL); 8 November 1965; dredge; discard. — 3♂, 7.4-9.3; 8♀, 6.4-14.4; 3 January 1966; trawl; FSBC I 1537. — 1♀, 11.2; 19 January 1966; trawl; stomach content; FSBC I 16678. — 1♀, 14.3; 7 February 1966; trawl; FSBC I 8998. — 1♂, 43(TL); 3 March 1966; trawl; discard. — 5♂, 45-54(TL); 15♀, 45-61(TL); 2 May 1966; trawl; discard. — 1♂, 41(TL); 2 May 1966; dredge; discard. — 1♀, 50(TL); 2 July 1966; trawl; discard. — 5♂, 31-43(TL); 8♀, 40-57(TL); 18 July 1966; trawl; discard. — 4♂, 29-38(TL); 1♀, 30(TL); 31 August 1966; dredge; discard. — 1♀, 13.3; 6 November 1966; dredge; FSBC I 15809. — 2♀, 11.6, 12.8; 1 December 1966; trawl; FSBC I 9012. — 1♂, 5.5; 20 January 1967; dredge; stomach content; FSBC I 16676. — 1♂, 9.4; 25 January 1967; trawl; FSBC I 6540. — 1♀, 12.2; 5 February 1967; trawl; FSBC I 9026. — 1♂, 6.6; 1♀, 9.5; 1 unsexed, 1.8; 1 August 1967; dredge; FSBC I 9046. — 1♀, 2.7; 11 August 1967; dredge; FSBC I 8078. — 1 unsexed, 1.4; 31 August 1967; dredge; FSBC I 8658. — 1♂,

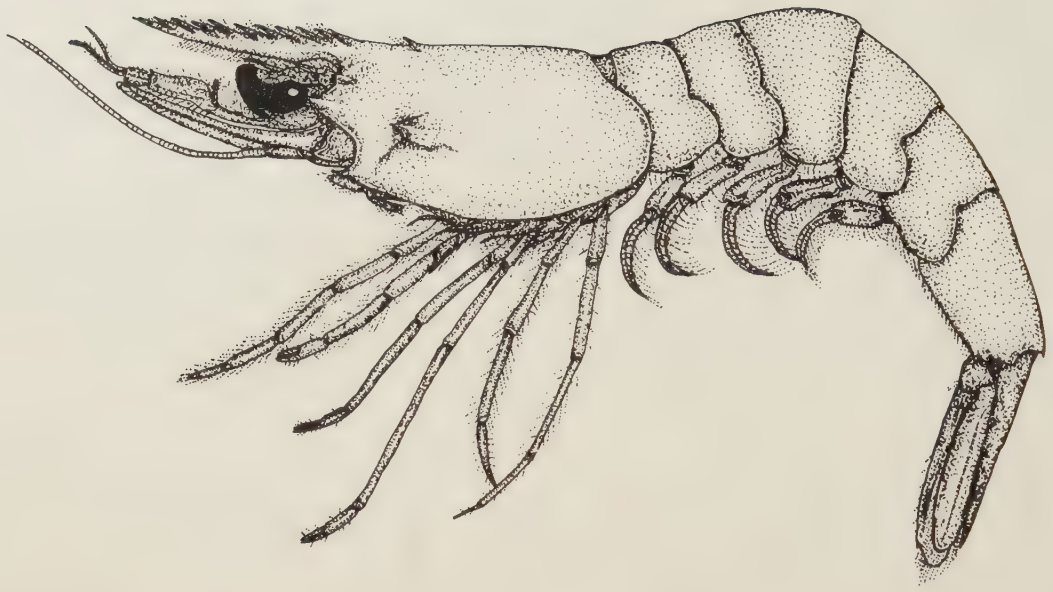


Figure 14. *Metapenaeopsis goodei*: ♀, 11.3 mm CL, FSBC I 8664. Pubescence omitted.

8.2; 11 September 1967; dredge; FSBC I 9060. — 5♂, 6.6-12.1; 8♀, 5.9-15.7; 5 October 1967; trawl; FSBC I 9061. — 4♂, 6.7-8.7; 1♀, 6.5; 5 October 1967; dredge; FSBC I 9062. — 6♂, 7.5-9.5; 6♀, 9.8-13.9; 4 damaged; 2 November 1967; trawl; FSBC I 8665. — 5♂, 4.4-9.1; 10♀, 4.0-9.9; 4 damaged; 2 November 1967; dredge; FSBC I 9068. — HOURGLASS STATION C: 1♀, 6.7; 3 August 1965; dredge; FSBC I 8995. — 1 unsexed, unmeasured; 31 August 1965; trawl; discard. — 5♂, 7.4-10.1; 4♀, 7.8-12.9; 8 November 1965; trawl; FSBC I 1133. — 1 damaged; 3 December 1965; trawl; FSBC I 8982. — 1♀, 30(TL); 3 December 1965; trawl; discard. — 1♀, damaged; 3 December 1965; dredge; FSBC I 16637. — 4♂, 35-48(TL); 7♀, 40-61(TL); 1♀, damaged; 3 January 1966; trawl; discard. — 1 damaged; 19 January 1966; trawl; FSBC I 17286. — 1♀, 51(TL); 16 April 1966; trawl; discard. — 3♀, 34-49(TL); 2 July 1966; trawl; discard. — 1♂, 7.6; 2 July 1966; dredge; FSBC I 9001. — 2♂, 8.5, 9.2; 3♀, 8.9-12.2; 18 July 1966; trawl; FSBC I 3346. — 1♀, 2.7; 18 July 1966; trawl; stomach content; FSBC I 17299. — 1♂, 8.7; 18 July 1966; trawl; stomach content; FSBC I 17306. — 2♀, 5.8, 6.9; 1 damaged, 1 August 1966; trawl; FSBC I 9002. — 10♂, 25-67(TL); 10♀, 39-53(TL); 1 August 1966; trawl; discard. — 1♀, damaged; 1 damaged, 4.0; 1 August 1966; dredge; FSBC I 9003. — 1♂, 47(TL); 1♀, 34(TL); 1 August 1966; dredge; discard. — 1♂, 36(TL); 3♀, 45-49(TL); 31 August 1966; trawl; discard. — 1♀, 12.9; 8 October 1966; trawl; FSBC I 15806. — 2♂, 8.6, 9.1; 1♂, damaged; 6♀, 5.0-9.2; 1♀, damaged; 1 damaged, 3.5; 8 October 1966; FSBC I 9006. — 1♂, 5.1; 19 November 1966; trawl; FSBC I 9009. — 2♂, 4.9, 7.9; 1♀, 8.2; 19 November 1966; dredge; FSBC I 9010. — 2♂, 7.0, 8.1; 5♀, 8.4-13.3; 1 damaged; 1 December 1966; trawl; FSBC I 9013. — 1♂, 9.3; 1♀, 8.2; 1 December 1966; dredge; FSBC I 9014. — 2♀, 2.6, 12.2; 13 December 1966; dredge; FSBC I 16640. — 1♂, 7.2; 1 damaged; 20 January 1967; dredge; FSBC I 9022. — 1♀, 6.0; 5 February 1967; dredge; FSBC I 9027. — 1♀, 13.6; 1 damaged; 2 March 1967; trawl; FSBC I 9030. — 2♀, 5.5, 10.6; 2 March 1967; dredge; FSBC I 9031. — 2♀, 11.2, 11.5; 3 April 1967; trawl; FSBC I 9032. — 1♂, damaged; 3 April 1967; dredge; FSBC I 16638. — 4♂, 7.5-11.1; 1♀, 12.1; 1 damaged; 2 June 1967; trawl; FSBC I 9035. — 1♀, 3.0; 1 July 1967; trawl; FSBC I 9040. — 3♂, 7.5-12.9; 1 July 1967; dredge; FSBC I 9041. — 1 damaged; 5 July 1967; dredge; FSBC I 14585. — 1♂, 8.8; 1♀, 12.1; 11 July 1967; trawl; FSBC I 9045. — 3♂, 8.5-11.3; 3♀, 11.1-12.8; 1 August 1967; trawl; FSBC I 9047. — 4♂, 7.7-9.8; 2♀, 10.2, 15.9; 11 August 1967; trawl; FSBC I 9051. — 1♂, 10.2; 2♀, 10.0, 12.6; 11 August 1967; dredge; FSBC I 9052. — 5♂, 8.4-10.6; 6♀, 11.3-14.9; 3 damaged; 31 August 1967; trawl; FSBC I 9053. — 8♂, 7.2-11.1; 7♀, 8.3-15.4; 5 October 1967; trawl; FSBC I 9063. — 1♂, 9.2; 1♀, 4.7; 5 October 1967; dredge; FSBC I

9064. — 1♀, 9.5; 5 October 1967; trawl; stomach content; FSBC I 17303. — 11♂, 6.7-11.1; 13♀, 3.1-14.2; 2 November 1967; trawl; FSBC I 9069. — 1 damaged; 21 November 1967; trawl; FSBC I 9075. — HOURGLASS STATION D: 1♂, 49(TL); 1♀, 55(TL); 4 January 1966; trawl; discard. — 1♂, 39(TL); 11 July 1966; trawl; discard. — 2♂, 40, 45(TL); 1♀, 61(TL); 19 July 1966; trawl; discard. — 2 damaged; 2 August 1966; dredge; FSBC I 9004. — 3♂, 8.2-11.4; 9♀, 7.3-12.9; 9 October 1966; trawl; FSBC I 15808. — 1♂, 8.9; 20 November 1966; trawl; FSBC I 9011. — 1♀, 9.7; 20 November 1966; trawl; stomach content; FSBC I 16679. — 2♀, 7.1, 8.1; 1 damaged; 2 December 1966; trawl; FSBC I 9015. — 2♀, 9.4, 12.0; 14 December 1966; trawl; stomach content; FSBC I 16680. — 1♂, 10.8; 1♀, 9.3; 6 February 1967; trawl; FSBC I 9028. — 1♂, 7.2; 12 May 1967; dredge; FSBC I 9034. — 1 unsexed, 2.2; 21 May 1967; dredge; FSBC I 17285. — 2♂, 8.5, 9.1; 1♀, 13.5; 3 June 1967; trawl; FSBC I 9036. — 1♀, 8.7; 2 July 1967; trawl; FSBC I 9042. — 1♂, 4.9; 1 September 1967; dredge; FSBC I 9054. — 1♂, 8.7; 1♀, 10.2; 3 November 1967; trawl; FSBC I 9070. — HOURGLASS STATION E: 1♀, 12.0; 9 November 1966; trawl; FSBC I 8663. — 2♀, 11.3, 13.2; 26 January 1967; trawl; FSBC I 8664. — 1♀, damaged; 30 January 1967; trawl; stomach content; FSBC I 16677. — HOURGLASS STATION J: 1♂, 39(TL); 1♀, 50(TL); 12 November 1965; trawl; discard. — 1♀, 12.4; 6 December 1965; trawl; FSBC I 1433. — 6♂♂, 6.1-8.9; 4♀, 8.1-13.4; 13 January 1966; trawl; FSBC I 8996. — 1♂, 7.2; 14 February 1966; trawl; FSBC I 8999. — 2♀, 41, 43(TL); 21 March 1966; trawl; discard. — 1♀, 5.1; 12 January 1967; trawl; FSBC I 9019. — 1♀, 3.1; 30 January 1967; trawl; FSBC I 6731. — 1♀, 9.2; 14 November 1967; dredge; FSBC I 9071. — HOURGLASS STATION K: 1♂, 7.2; 3♀, 7.8-9.6; 6 August 1965; trawl; FSBC I 783. — 2 unsexed, unmeasured; 4 September 1965; trawl; discard. — 2♀, 8.7, 10.0; 21 March 1966; trawl; FSBC I 9000. — 4♀, 53-62(TL); 11 April 1966; trawl; discard. — 1♂, 44(TL); 11 May 1966; trawl; discard. — 2♂, 42, 44(TL); 5♀, 33-58(TL); 12 June 1966; trawl; discard. — 8♂, 32-48(TL); 8♀, 35-47(TL); 5 July 1966; trawl; discard. — 1♂, 45(TL); 1♀, 46(TL); 5 July 1966; dredge; discard. — 24♂, 23-50(TL); 35♀, 24-60(TL); 5 August 1966; trawl; discard. — 1♀, 51(TL); 5 August 1966; dredge; discard. — 13♂, 5.7-8.2; 20♀, 7.6-14.0; 4 damaged; 4 September 1966; trawl; FSBC I 4004. — 1 damaged; 4 September 1966; trawl; stomach content; FSBC I 17301. — 1♂, 8.7; 5♀, 10.0-15.6; 6 December 1966; trawl; FSBC I 9016. — 1♂, 8.2; 1♀, 5.0; 1 unsexed, 2.6; 6 December 1966; dredge; FSBC I 9017. — 1♀, damaged; 30 January 1967; trawl; FSBC I 9023. — 2♀, 6.7, 9.5; 1 damaged, 4.0; 15 February 1967; trawl; FSBC I 9029. — 1♂, 7.2; 1♀, 8.9; 1♀, damaged; 7 April 1967; dredge; FSBC I 9033. — 8♂, 7.4-10.6; 6♀, 8.0-10.0; 1 damaged; 6 June 1967; trawl; FSBC I 9037. — 12♂, 5.1-12.9; 12♀, 5.0-13.6; 6 June 1967; dredge; FSBC I 9038. — 1 damaged, 3.9; 11 July 1967; dredge; FSBC I 15158. — 2♀, 10.8, 11.5; 7 August 1967; trawl; FSBC I 9048. — 1♂, 9.4; 5♀, 9.7-14.5; 2 damaged; 4 September 1967; trawl; FSBC I 9055. — 6♀, 4.7-12.9; 4 September 1967; dredge; FSBC I 9056. — 2♀, 9.6, 13.0; 11 October 1967; trawl; FSBC I 9065. — 1 damaged, 7.7; 11 October 1967; trawl; stomach content; FSBC I 17302. — 2♀, 8.1, 16.6; 14 November 1967; trawl; FSBC I 9072. — 1♂, damaged; 14 November 1967; dredge; FSBC I 16639. — HOURGLASS STATION L: 1♀, 51(TL); 13 November 1965; trawl; discard. — 4♀, 45-60(TL); 6 July 1966; trawl; discard. — 1♀, 59(TL); 22 July 1966; trawl; discard. — 1♂, 49(TL); 6♀, 42-62(TL); 6 August 1966; trawl; discard. — 10♂, 41-53(TL); 9♀, 28-62(TL); 5 September 1966; trawl; discard. — 1♀, 13.8; 13 October 1966; trawl; FSBC I 2817. — 1♂, 11.1; 1♀, 13.0; 13 November 1966; trawl; FSBC I 9007. — 1♀, 13.6; 1♀, damaged; 1 damaged; 13 January 1967; trawl; FSBC I 9020. — 3♀, 10.1-12.8; 31 January 1967; trawl; FSBC I 9024. — 1♀, 13.6; 7 June 1967; trawl; FSBC I 9039. — 1♂, 5.9; 6 July 1967; trawl; FSBC I 9043. — 1♀, damaged; 6 July 1967; dredge; FSBC I 9044. — 1♂, 9.8; 3♀, 4.8-11.8; 1♀, damaged; 1 damaged; 8 August 1967; trawl; FSBC I 9049. — 3♀, 7.1-11.9; 5 September 1967; trawl; FSBC I 9057. — 1♂, 9.5; 5 September 1967; dredge; FSBC I 9058. — 2♂, 4.6, 9.3; 3♀, 4.6-10.9; 3 damaged; 12 October 1967; trawl; FSBC I 9066. — 1♀, 15.4; 12 October 1967; dredge; FSBC I 7583. — 1♂, 9.7; 3♀, 10.0-13.7; 15 November 1967; trawl; FSBC I 9073. — 1♂, 8.9; 15 November 1967; dredge; FSBC I 9074. — HOURGLASS STATION M: 1♀, 11.8; 14 December 1965; trawl; FSBC I 1464. — 1♂, 9.6; 14 January 1966; trawl; FSBC I 8997. — 1♀, 48(TL); 15 February 1966; trawl; discard. — 1♂, 45(TL); 2♀, 51, 55(TL); 6 August 1966; trawl; discard. — 1♂, 7.1; 5 September 1966; trawl; FSBC I 9005. — 1♂, 43(TL); 5 September 1966; trawl; discard. — 1 damaged, 15.6; 13 November 1966; trawl; FSBC I 9008. — 1♀,

11.0; 7 December 1966; trawl; FSBC I 9018. — 1♀, 8.7; 13 January 1967; trawl; FSBC I 9021. — 1♀, 10.9; 31 January 1967; trawl; FSBC I 9025. — 2♀, 48, 52(TL); 31 January 1967; trawl; discard. — 1♀, 11.3; 8 August 1967; trawl; FSBC I 9050. — 4♀, 6.3-13.1; 1 damaged; 5 September 1967; trawl; FSBC I 9059.

Diagnosis: Body almost entirely covered by plumose, densely set setae. Stylocerite long, extending to base of distal third of first antennular segment. Third pereopod short, reaching at most to distal end of second antennular segment. Abdomen with long middorsal carina, extending at least from anterior end of third somite to posterior margin of sixth somite. Telson with long, slender terminal portion. Petasma with right distoventral projection shallowly cleft into two unequal lobes, right lobe larger than left. Thelycum with median plate densely covered by setae, anterior part long, strongly concave, with short bosses, produced anteromedially into small pits; transverse plate tilted anteroventrally (Pérez Farfante, 1971).

Description: Pérez Farfante, 1971, pp. 10-14.

Geographic and bathymetric range: Between Cape Hatteras and Cape Lookout, North Carolina, southward through the Florida Keys and Gulf of Mexico to Pensacola, Florida; Bermuda; West Indies; Yucatán southward along Caribbean and Atlantic coasts of South America to Salvador, Brazil (12°58′S). Shallow water to 329 m, mostly at depths less than 60 m. (Williams, 1965; Pérez Farfante, 1971.)

Remarks: Six hundred eighty-six specimens (1.4-16.6 mm CL) were caught in trawls and dredges (Table 6); an additional 11 shrimp were recovered from fish stomachs. Although intertransect depth distribution was markedly dissimilar, north and south transects shared an almost equal number of occurrences (Figure 15). Different relative abundances at 18 m stations (39% of catch, north transect; 9%, south transect) was probably caused by patchy areal distribution rather than presence or absence of a preferred habitat characteristic.

Salinity and temperature ranges for this species were 31.22-36.71 ‰ and 13.9-30.0°C. Camp et al. (1977) reported 34.8-39.3 ‰ and 25.5-26.0°C.

TABLE 6. *Metapenaeopsis goodei*: MONTHLY OCCURRENCES AT HOURGLASS STATIONS. TRAWL CAPTURES (TOP NO.), DREDGE CAPTURES (BOTTOM NO.).

Metapenaeopsis goodei

STA	1965					1966													1967										TOT
	A	S	O	N	D	J	F	M	A	M	J	J	J sp	A	S	O	N	D	J	J sp	F	M	A	M	J	J	A	S	O	N	
A																															
B_1		12		5 4		11	1	1		20 1		1	13		5		1	2		1	1						3	1	13 5	16 19	97 39
B_2	1																										1	1			1 2
C_1	1	1		9	2 1	12						3 1	5	23 4	4	1 11		8 2			1	2 2	2 1		6	1 3	6	14	15 2	24	138 29
C_2						1			1								1 3	2 2	2							2 1	6 3			1	12 11
D_1						2							3	2		12		3			2			1	3	1		1		2	28 4
D_2												1					1							1							2 1
E																	1			2											3
I																															
J				2	1	10	1	2											1	1										1	18 1
K	4	2						2	4	1	7	16 2		59 1	37			6 3		1	3			3		15 24	1	2	8 6	2	2 1	171 41
L				1								4	1	7	19	1	2		3	3						1	1 1	6	3 1	8 1	4 1	64 4
M					1	1	1							3	2		1	1	1	3								1	5			20
TOT	5 1	15		17 4	4 1	37	3	5	5	21 1	7	25 3	22	92 7	62 5	14 11	6 4	20 7	5 2	11	6 1	2 2	2 4	2	25 24	5 6	21 7	30 10	38 8	49 22	554 132

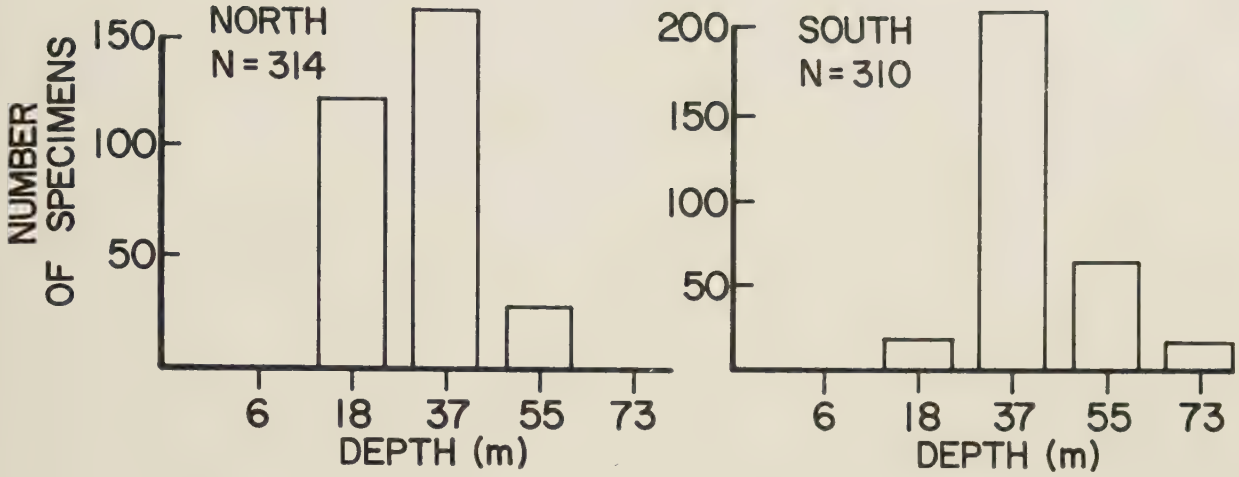


Figure 15. *Metapenaeopsis goodei*: Abundance at stations on north and south transects during regular sampling.

Metapenaeopsis goodei has been generally associated with firm substrates. Pérez Farfante (1977) listed coral reefs, rocks, broken shells, gravel, sand and mud. Additionally, Camp et al. (1977) found their only specimens at a station with substrates almost equally divided between large shell, very coarse sand, coarse sand, and medium sand. Hourglass substrates where *M. goodei* commonly occurred were exposed limestone, quartz sand, crushed shell and shell sand, occasionally veneered with calcareous silt.

Temporal distribution data revealed a tendency toward increased occurrence during summer and fall (Figure 16). Seasonal data from other studies in Florida waters is sparse. Camp et al. (1977) captured specimens only in June and August on Florida's east coast. Eldred (1959) captured nine small specimens in May and June in Tortugas shrimping areas. In the Bermudas, this shrimp was most abundant in summer (Wheeler, 1937). Increased occurrences during warmer temperatures seem characteristic, regardless of location.

Diurnal sampling yielded about 8% of the catch at Stations B, C and D. Other studies have indicated that *M. goodei* is nocturnal. Wheeler (1937) periodically observed these shrimp on the water surface about an hour after sunset. He also noticed more shrimp during dark lunar phases, further substantiating night activity.

During regular sampling, dredges collected about 19% of our specimens. As with other Hourglass penaeoids, dredges were more successful at diurnally sampled stations, yielding 48% of the daylight catch. The 13.7 m trawl collected 6% of all night trawled specimens.

Size frequency analysis revealed little associated life history information (Figure 17). There were no obvious pulses of juvenile recruitment and consequent monthly modal progressions. However, growth of 1 mm CL per month was observed during June through August (size classes 8 to 10). A similar progression occurred September through November. Numerically limited data for January through May made further growth observations impossible.

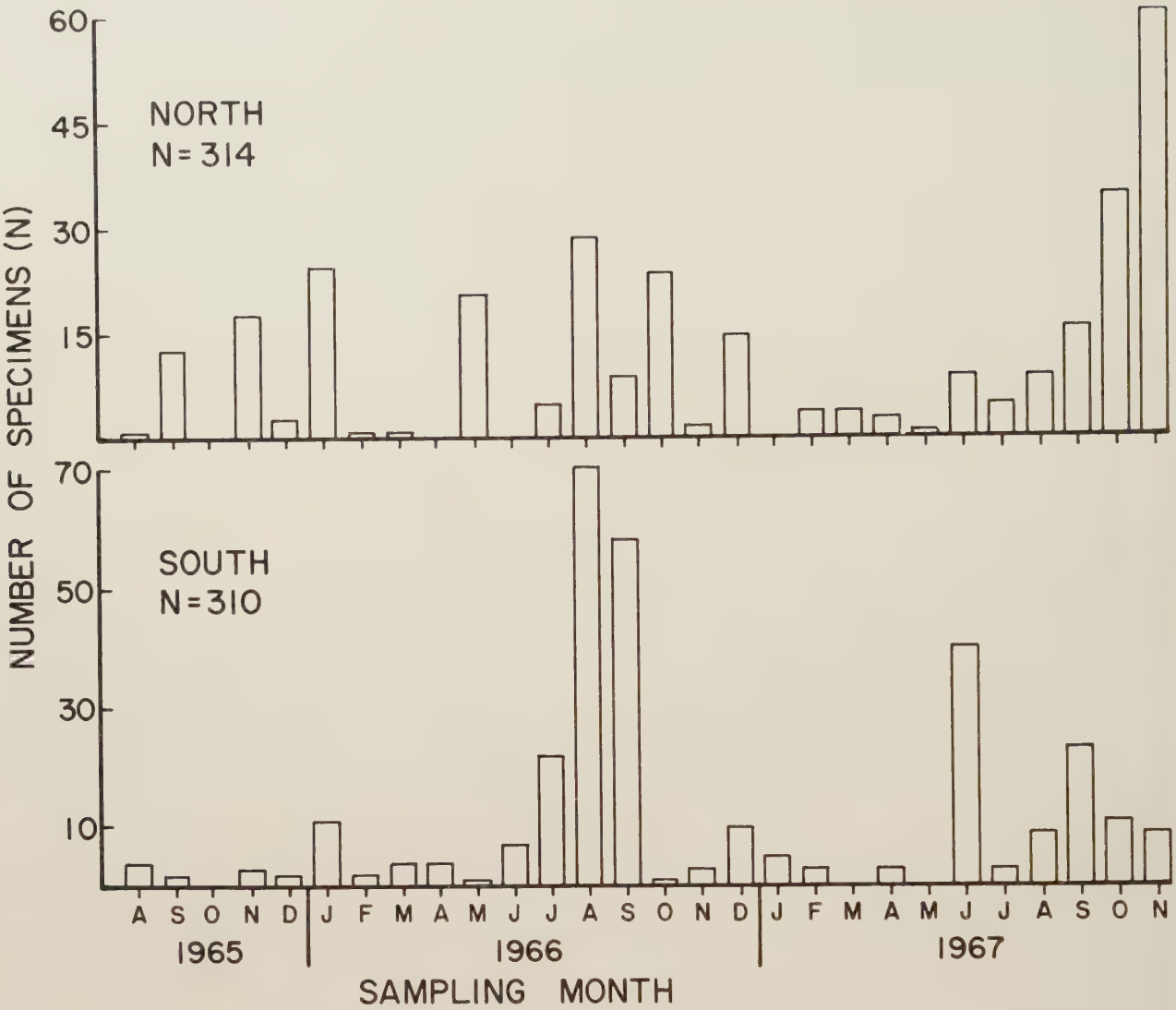


Figure 16. *Metapenaeopsis goodei*: Intertransect monthly abundance during regular sampling.

Length ranges for Hourglass specimens were: males, 2.7-12.9 mm CL; females, 2.6-16.6 mm CL. The 16.6 mm CL female may be near the upper limit of growth for this species. Pérez Farfante (1971) observed a maximum length of 16.0 mm CL for a female captured off Isla Mujeres, Mexico.

Overall male/female sex ratio (0.63) was the highest of non-commercial Hourglass Penaeoidea. An approximate 1.00 ratio during the last 24 sampling months was indicated for specimens less than 11.4 mm CL (Figure 18). Females consistently dominated larger size classes, and no males were found greater than 12.9 mm CL. The overall ratio statistically approximated 1:1.5 (0.66). Gear selectivity probably had little influence on observed ratios since sex/size differences were small; only 10% of females were larger than the largest male.

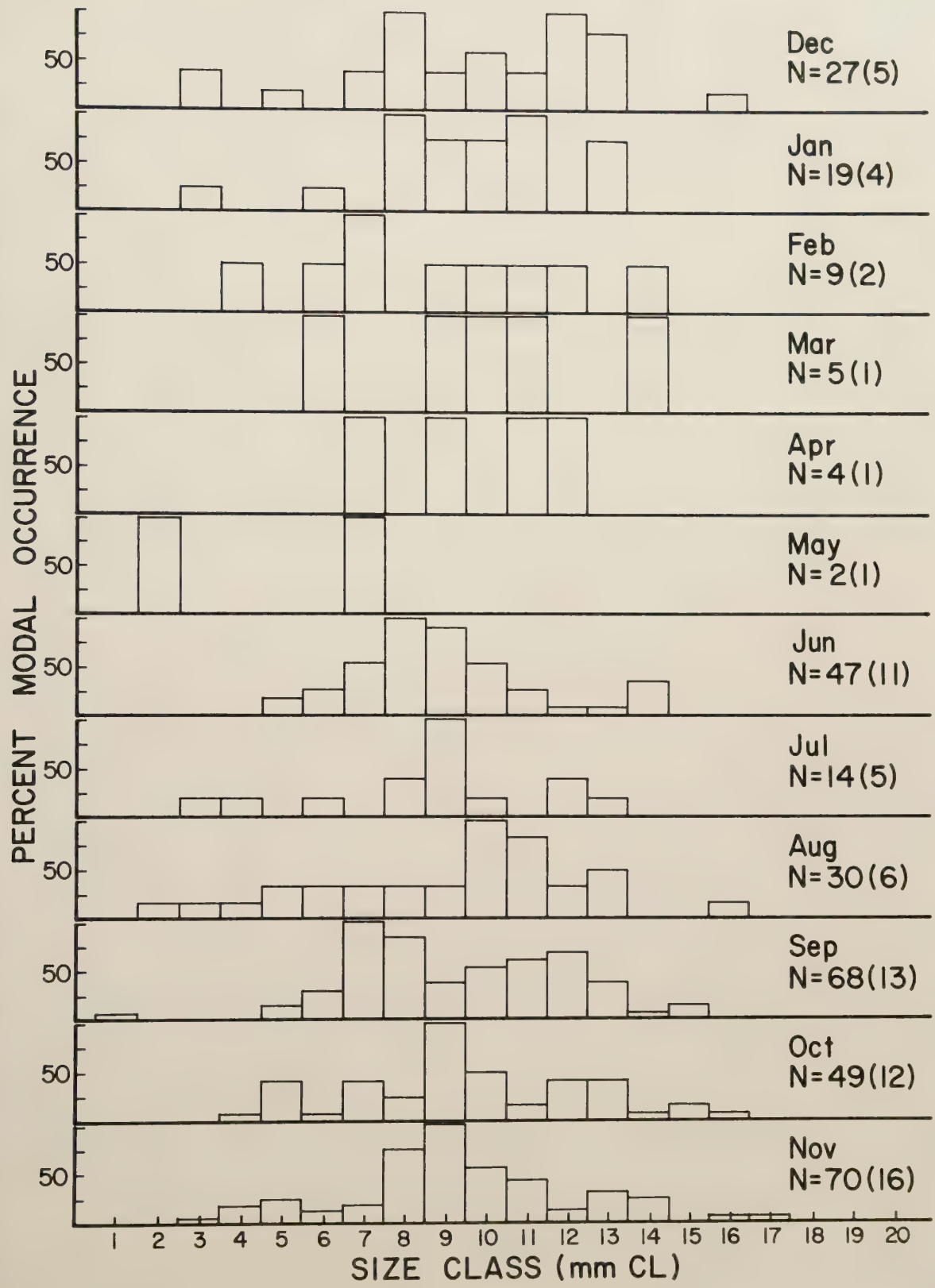


Figure 17. *Metapenaeopsis goodei*: Combined monthly length frequencies for last 24 sampling months. 1 mm CL size classes, total N (modal N).

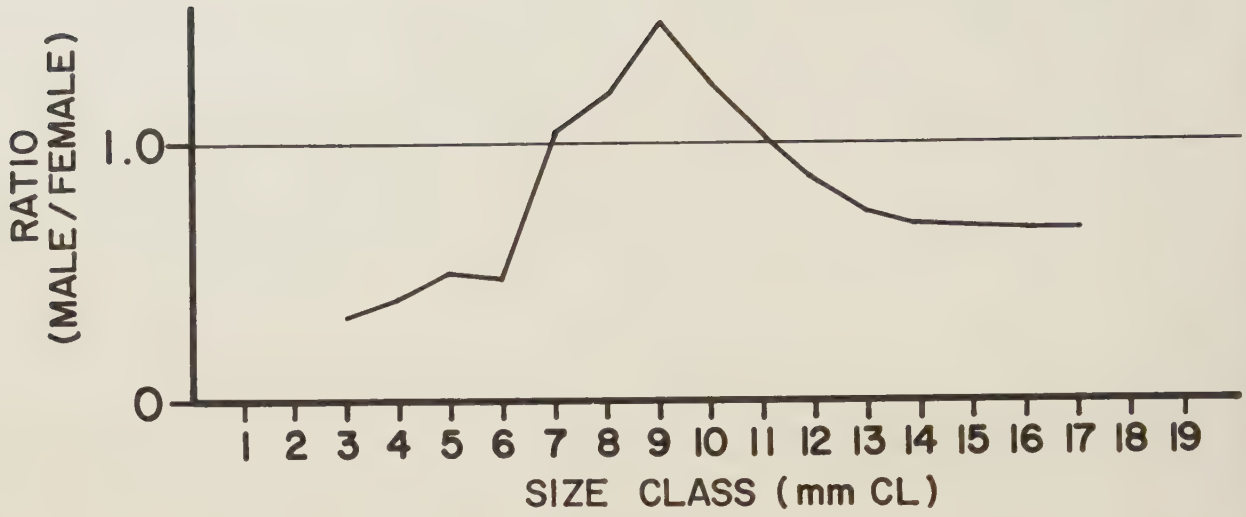


Figure 18. *Metapenaeopsis goodei*: Cumulative male/female ratio for last 24 sampling months. 1 mm CL size classes.

Macroscopic examination of reproductive characters revealed a spawning pattern coinciding with increased summer and fall abundance. Impregnated females were encountered in June, August, September, October and December. These specimens ranged from 8.0 to 15.6 mm CL but were smallest in June ($\overline{CL}$ = 9.9 mm) and largest in December ($\overline{CL}$ = 13.2 mm). Increased occurrences during this period may have resulted from spawning aggregation, which may have also contributed to patchy areal distribution generally encountered during summer and fall.

Male maturity began at about 4.0 mm CL and was completed for all males by about 6.0 mm CL.

Twenty-five stomachs of *Metapenaeopsis goodei* (9.2-15.5 mm CL) from night sampling (Stations C, October and November; K, September) were examined. Fifteen of these were 100% full; none were empty (Table 7). Crustaceans were by far the major dietary material. *Galathea rostrata* Milne Edwards, 1880 and/or *Munida irrasa* Milne Edwards, 1880 completely filled one stomach, and fragments of a palaemonid shrimp (subfamily Pontoniinae) dominated another. A gastropod, *Vermicularia knorri* (Deshayes, 1843), was found residually in one stomach. Unidentifiable organic debris was found in many stomachs, consisting mostly of animal material. *Metapenaeopsis goodei* appears to be a generalized benthic carnivore.

Eleven *Metapenaeopsis goodei* (2♂, 2.7-5.5 mm CL; 9♀, 7.7-12.0 mm CL) were recovered from five species of fish and a skate (*Raja texana* Chandler). Five *Scorpaena calcarata* trawled at Stations C and K had consumed this shrimp. *M. goodei* also contributed to the diets of *Scorpaena brasiliensis* (Station D), *Rypticus maculata* Holbrook (Station B), *Kathetostoma albigutta* (Bean) (Station D), and *Holocentrus bullisi* Woods (Station E).

TABLE 7. *Metapenaeopsis goodei*: FOOD ITEM CONTENT AND COMPOSITION IN 25 STOMACHS.

Item	Predominant		Residual		Total	
	N	%	N	%	N	%
Foraminiferida	0	—	8	32	8	32
Nematoda	0	—	8	32	8	32
Polychaeta	3	12	1	4	4	12
Mollusca						
Unidentifiable fragments	1	4	2	8	3	12
Bivalvia	3	12	3	12	6	24
Gastropoda	5	20	5	20	10	40
Crustacea						
Unidentifiable fragments	13	52	3	12	16	64
Ostracoda	0	—	1	4	1	4
Copepoda	2	8	0	—	2	8
Brachyura	1	4	0	—	1	4
Caridea	1	4	0	—	1	4
Anomura	1	4	0	—	1	4
Organic debris	6	24	1	4	7	28

Genus *Penaeus* Fabricius, 1798

Penaeus duorarum Burkenroad, 1939

Figure 19

Penaeus duorarum Burkenroad, 1939, pp. 4, 21, 27, 30, 31-34, 36, 39-45, 51, figs. 23, 25 (part, "Form A"); Hildebrand, 1955, pp. 172, 174-179, 220, 224, 227; Eldred et al., 1961, 139 pp., fig. 26a; Tabb et al., 1962a, 32 pp.; Costello and Allen, 1966, pp. 449-459; Berry, 1967, 160 pp.; Christmas and Gunter, 1967, pp. 1442, 1443, 1445, 1446; Hughes, 1967a, pp. 867-874; 1967b, pp. 971-981; Knight and Berry, 1967, 83 pp.; Schafer, 1967a, 10 pp.; 1967b, 11 pp., 5 figs.; Temple and Fischer, 1967, p. 323; Wickham, 1967, pp. 769-786; Costello and Allen, 1968, pp. 491-502; Hughes, 1968, pp. 48-59; Jachowski and Myrberg, 1968, pp. 191-202; Kelly and Dragovich, 1968, pp. 209, 218; Munro et al., 1968, pp. 165-181; Ringo and Zamora, 1968, pp. 471, 475; Saloman et al., 1968, pp. 343-349; Hughes, 1969a, pp. 398-404; 1969b, pp. 43-53; Osburn et al., 1969, pp. 14-18; Roessler, et al., 1969, 7 pp.; Rouse, 1969, p. 135; Anderson, 1970, pp. 1, 5, 9, 10, 19, 21; Costello and Allen, 1970, pp. 1499-1537, figs. 1, 3A, 3B, 4; Berry, 1970, pp. 66-78; Jones et al., 1970, pp. 634-661; Villella et al., 1970, pp. 789-794; Fontaine and Neal, 1971, pp. 584-586; Gehring, 1971, 60 pp.; Roessler and Rehrer, 1971, pp. 790-805; Sastrakusumah, 1971, 37 pp.; Subrahmanyam, 1971a, pp. 225, 257; 1971b, pp. 292, 316, 328, 329, 331; Franks et al., 1972, pp. 52, 130; Lindall et al., 1973, pp. 158-162; Brown and Patlan, 1974, p. 23; Copeland and Bechtel, 1974, pp. 169-171, 173-180, 183, 187, 188, 195-197, 199; Martosubroto, 1974, pp. 606-627; Stokes, 1974, pp. 1, 14-17, 30, 31; Wood, 1974, p. 39, pl. 7, figs. 1, 3, 5, 7; Lindall et al., 1975, pp. 83, 84; Wickham and Minkler, 1975, pp. 21-35; Brusher and Ogren, 1976, pp. 158, 161-165; Trent et al., 1976, pp. 195-199; Christmas and Etzold, 1977, pp. 3-8, 11-13, 16, 17, 44, 45, 48; Livingston et al., 1977, pp. 90, 93; Pérez Farfante, 1978, 2 unnumbered pages, 5 unnumbered text-figs.

Penaeus duorarum duorarum: Pérez Farfante, 1969, pp. 499-520, figs. 20-31; Beardsley, 1970, pp. 401-408; Hudson et al., 1970, pp. 1, 8; Pérez Farfante, 1970, p. 4, figs. 3, 5, text-figs. 6b-10b, $11b_1$, $11b_2$, 12b-25b; Lyons et al., 1971, p. 28; Grizzle, 1974, p. 133; Camp et al., 1977, pp. 23, 43, 46.

Material examined: HOURGLASS STATION A: 12♂, 16.7-22.8; 6♀, 14.9-25.2; 30 August 1965; trawl; FSBC I 827. — HOURGLASS STATION B: 2 unsexed, unmeasured; 30 August 1965; trawl; discard. — 3♂, 3♀, 88-153(TL); 4 October 1965; trawl; discard. — 6♂, 97-147(TL); 1♀, 89(TL); 8 November 1965; trawl; discard. — 3♂, 29.5-32.8; 2♀, 36.0, 39.5; 1 damaged; 7 February 1966; trawl; FSBC I 14905. — 1♀, 148(TL); 20 February 1965; dredge; discard. — 1♀, 118(TL); 2 May 1966; trawl; discard. — 1♀, 141(TL); 2 July 1966; trawl; discard. — 1♀, 30.1; 18 October 1966; dredge; FSBC I 14906. — 1♂, 23.3; 6 November 1966; trawl; FSBC I 14907. — 1♀, 38.7; 25 January 1967; trawl; FSBC I 6486. — 4♂,

Figure 19. *Penaeus duorarum*: ♂, 29.3 mm CL, FSBC I 14932.

19.8-24.5; 3♀, 17.8-26.0; 2 November 1967; trawl; FSBC I 14933. — HOURGLASS STATION C: 2♂, unmeasured; 31 August 1965; trawl; discard. — 1♂, 108(TL); 8 November 1965; trawl; discard. — 1♂, 132(TL); 3 December 1965; trawl; discard. — 12♂, 122-162(TL); 6♀, 138-183(TL); 3 March 1966; trawl; discard. — 3♂, 135-144(TL); 16 April 1966; trawl; discard. — 4♂, 22.0-34.6; 2♀, 42.2, 47.8; 2 July 1966; trawl; FSBC I 3137. — 7♂, 27.0-39.0; 3♀, 31.1-51.2; 18 July 1966; trawl; FSBC I 3341. — 3♂, 141-168(TL); 2♀, 161, 184(TL); 31 August 1966; trawl; discard. — 11♂, 24.5-30.5; 2♀, 30.5, 30.9; 6 November 1966; trawl; FSBC I 14908. — 10♂, 25.0-31.2; 5♀, 30.1-36.6; 1 December 1966; trawl; FSBC I 14912. — 1♂, 27.7; 1 December 1966; dredge; FSBC I 14913. — 1♂, 32.5; 13 December 1966; trawl; FSBC I 14916. — 3♂, 26.1-28.9; 3♀, 36.4-39.7; 6 January 1967; trawl; FSBC I 14917. — 6♂, 29.9-33.6; 8♀, 22.4-42.9; 25 January 1967; trawl; discard. — 1♂, 33.8; 2♀, 37.9, 49.6; 2 March 1967; trawl; FSBC I 14923. — 1♀, 44.3; 11 May 1967; trawl; FSBC I 14925. — 1♀, 35.1; 21 June 1967; trawl; FSBC I 14927. — 1♂, 27.5; 1♀, 36.6; 21 June 1967; dredge; FSBC I 14928. — 2♂, both 26.4; 1 August 1967; trawl; FSBC I 14929. — 1♂, about 42.0; 5♀, 38.7-51.5; 2 November 1967; trawl; FSBC I 14934. — HOURGLASS STATION I: 2♂, 79, 80(TL); 3♀, 73-113(TL); 12 October 1965; trawl; discard. — 2♂, unmeasured; 12 October 1965; dredge; discard. — 1♀, 92(TL); 12 November 1965; dredge; discard. — 1♀, 119(TL); 9 March 1966; trawl; discard. — 1♀, 30.6; 12 January 1967; dredge; FSBC I 14918. — HOURGLASS STATION J: 1 unsexed, unmeasured, 6 August 1965; dredge; discard. — 2 unsexed, unmeasured; 3 September 1965; trawl; discard. — 1♂, 102(TL); 6♀, 61-159(TL); 12 October 1965; trawl; discard. — 3♂, 25.0-31.2; 3♀, 26.7-42.6; 12 November 1965; trawl; FSBC I 1166. — 2♂, 24.4, 26.2; 5♀, 25.1-34.4; 13 January 1966; trawl; FSBC I 1644. — 9♂, 83-150(TL); 11♀, 110-179(TL); 14 February 1966; trawl; discard. — 1♂, 127(TL); 1♀, 145(TL); 14 February 1966; dredge; discard. — 2♂, 144, 147(TL); 4♀, 146-188(TL); 21 March 1966; trawl; discard. — 1♀, 127(TL); 12 June 1966; dredge; discard.

— 1♂, 21.4; 4♀, 36.4-48.4; 21 July 1966; trawl; FSBC I 3428. — 4♂, 23.3-32.3; 3♀, 22.8-32.4; 12 November 1966; trawl; FSBC I 14909. — 1♂, 22.6; 12 November 1966; trawl; stomach content; FSBC I 16671. — 7♂, 16.3-27.1; 4♀, 23.5-44.7; 6 December 1966; trawl; FSBC I 14914. — 1♀, damaged; 6 December 1966; dredge; FSBC I 14915. — 1♂, 28.3; 3♀, 26.8-37.5; 12 January 1967; trawl; FSBC I 14919. — 4♂, 23.1-33.1; 3♀, 27.2-41.1; 30 January 1967; trawl; FSBC I 14920. — 1♀, 33.3; 15 February 1967; trawl; FSBC I 14922. — 8♂, 13.4-22.2; 5♀, 13.0-27.0; 11 October 1967; trawl; FSBC I 14931. — 4♂, 19.4-25.0; 5♀, 20.5-31.9; 14 November 1967; trawl; FSBC I 14935. — HOURGLASS STATION K: 3♂, 24.6-37.8; 1♀, 29.0; 6 August 1965; trawl; FSBC I 784. — 1♂, 137(TL); 13 October 1965; trawl; discard. — 1♀, 142(TL); 13 October 1965; dredge; discard. — 5♂, 109-131(TL); 7♀, 106-144(TL); 12 November 1965; trawl; discard. — 1♂, 119(TL); 5♀, 124-141(TL); 7 December 1965; trawl; discard. — 6♂, 125-148(TL); 1♀, 164(TL); 13 January 1966; trawl; discard. — 1♂, 128(TL); 2♀, 122, 160(TL); 21 March 1966; trawl; discard. — 2♂, 142, 150(TL); 2♀, 117, 141(TL); 11 April 1966; trawl; discard. — 3♂, 147-154(TL); 2♀, 158, 166(TL); 5 July 1966; trawl; discard. — 1♂, 165(TL); 3♀, 86-180(TL); 22 July 1966; trawl; discard. — 2♂, 19.9, 22.3; 1♀, 29.8; 12 October 1966; trawl; FSBC I 1064. — 2♂, 21.9, 28.0; 2♀, 29.0, 32.3; 12 November 1966; trawl; FSBC I 14910. — 13♂, 30.1-34.8; 5♀, 33.1-40.5; 1 damaged; 30 January 1967; trawl; FSBC I 14921. — 1♀, 44.7; 7 April 1967; trawl; FSBC I 14924. — 2♀, 42.6, 45.6; 15 May 1967; trawl; FSBC I 14926. — 1♂, 30.0; 7 August 1967; trawl; FSBC I 14930. — 2♂, 29.3, 38.9; 11 October 1967; trawl; FSBC I 14932. — 2♂, 23.3, 27.3; 3♀, 33.1-35.1; 14 November 1967; trawl; FSBC I 14936. — 1♀, 38.5; 14 November 1967; dredge; FSBC I 14937. — HOURGLASS STATION M: 1♀, 30.6; 13 November 1966; trawl; FSBC I 14911.

Diagnosis: Adrostral sulcus broad posteriorly, long, almost reaching posterior margin of carapace. Median sulcus long, ending immediately anterior to posterior end of adrostral sulcus, deep along entire length. Dorsolateral sulcus narrow, sometimes almost closed. Petasma with distal portion of ventral costa broadening, turning proximally rather abruptly, armed with minute spines along free border, compact group of large teeth on attached border; apex of ventral costa adnate to adjacent wall; distal fold small, unarmed or with few submarginal spinules. Thelycum with relatively large anterior process, prominent undivided median carina on posterior process; carina exposed owing to slight divergence of anteromedian corners of lateral plates (Pérez Farfante, 1969).

Description: Pérez Farfante, 1969, pp. 503-508.

Geographic and bathymetric range: Chesapeake Bay, Virginia, to Florida Keys and Gulf of Mexico to Isla Mujeres, Mexico; Bermuda; Cay Sal Bank, Florida Straits; shallow water to 329 m; most abundant between 11 and 65 m.

Remarks: Pérez Farfante (1969) and Costello and Allen (1970) have presented excellent summations and discussions of *Penaeus duorarum*. These should be consulted for detailed assessments of many topics discussed here.

Three hundred sixty-nine *P. duorarum* (13.0-51.5 mm CL) were captured during regular sampling (Table 8); one additional specimen was obtained from fish stomachs. Pink shrimp were limited to 6, 18 and 37 m stations except for one specimen taken at Station M (73 m). More numerous on the southern transect, its peak abundance occurred at Station J (18 m). However, northern transect peak abundance was at Station C (36 m), making this one of two Hourglass penaeoids to display dissimilar intertransect modal depth distribution (Figure 20).

TABLE 8. *Penaeus duorarum*: MONTHLY OCCURRENCES AT HOURGLASS STATIONS. TRAWL CAPTURES (TOP NO.), DREDGE CAPTURES (BOTTOM NO.).

Penaeus duorarum

STA	1965					1966								1967															TOT
	A	S	O	N	D	J	F	M	A	M	J	J	J sp	A	S	O	N	D	J	J sp	F	M	A	M	J	J	A	S	O	N	
A		18																													18
B_1		2	6	7			6			1		1					1			1									7		32
B_2							1									1														2
C_1		2		1	1			18				6	10		5		13	15 1	6	14		3		1			2			6	103 1
C_2									3									1							1 2						5 2
D_1																															
D_2																															
E																															
I			5 2	1				1											1												6 4
J	1	2	7	6		7	20 2	6			1		5				7	11 1	4	7	1								13	9	105 5
K	4		1 1	12	6	7		3	4			5	4			3	4			19			1	2			1		2	5 1	83 2
L																															
M																	1														1
TOT	4 1	24	19 3	26 1	7	14	26 3	28	7	1	1	12	19		5	3 1	26	27 2	10 1	41	1	3	1	3	1 2		3		15	27 1	353 16

Pérez Farfante (1969) was first to report *P. duorarum* from Yucatán's northern and eastern shore; closely related *Penaeus notialis* Pérez Farfante, 1967, replaces it south of Ascensión Bay. Commercial Gulf of Mexico fisheries are located on the Campeche Banks off the western Yucatán Peninsula and from the Tortugas grounds near Dry Tortugas, Florida, northward along the Gulf coast to the Mississippi River (Hildebrand, 1955; Eldred et al., 1961; Tabb et al., 1962a; Pérez Farfante, 1969, 1978; Costello and Allen, 1970).

Pink shrimp are euryhaline, exhibiting increasing preference for higher salinity and deeper water with increasing age (Costello and Allen, 1970). All Hourglass *P. duorarum* were captured in salinities of 32.63 to 36.45 ‰; temperatures ranged from 13.9 to 30.5°C.

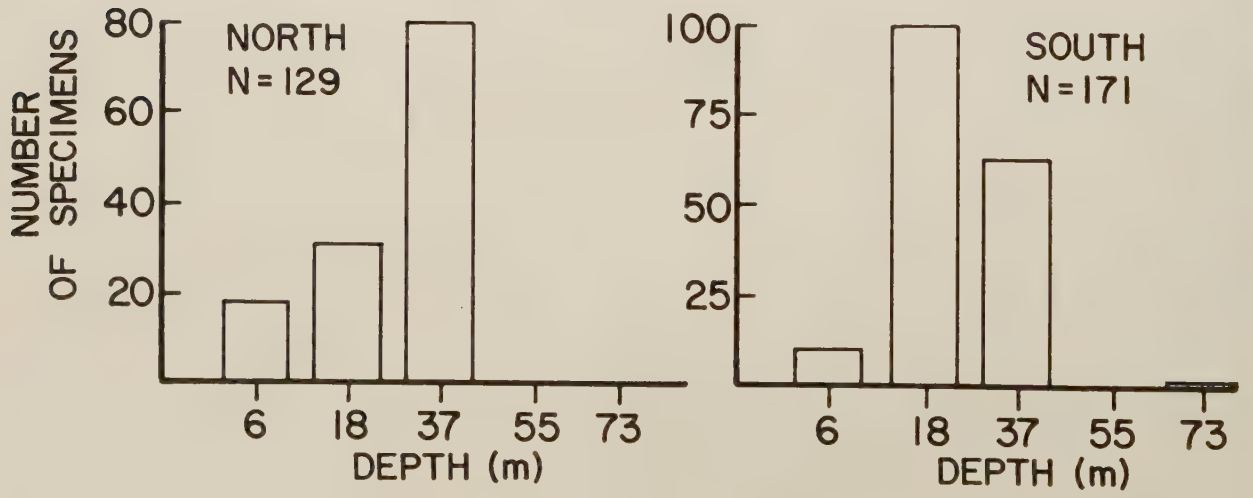


Figure 20. *Penaeus duorarum*: Abundance at stations on north and south transects during regular sampling.

Substrates at stations of higher abundance (C and J) were chiefly sand, sand-shell, and exposed limestone; a calcareous silt layer and calcium particles were variously present at Station C. Similar substrate preferences were listed by Pérez Farfante (1969) and Costello and Allen (1970).

Temporal fluctuations of abundance between transects were similar (Figure 21), with a tendency toward greater catches from late fall to early spring. At northern stations, peak occurrences were in March, September, November, and December; commercial catches during these same months were low or non-existent (Figure 22). Southern stations had peak occurrences in October through November and in March 1966, again displaying no obvious correlations with commercial catches for the same time period (Figure 23).

Striking anomalies between U. S. Department of Commerce commercial landing statistics and Hourglass catches in the north (Figure 22) were related to redirected shrimping efforts. Tampa Bay area production (Grid 5) was lowest from September to May during peak Hourglass occurrences. Most Tampa Bay based boats typically moved to the more productive Tortugas and Sanibel (Grid 4) grounds during these

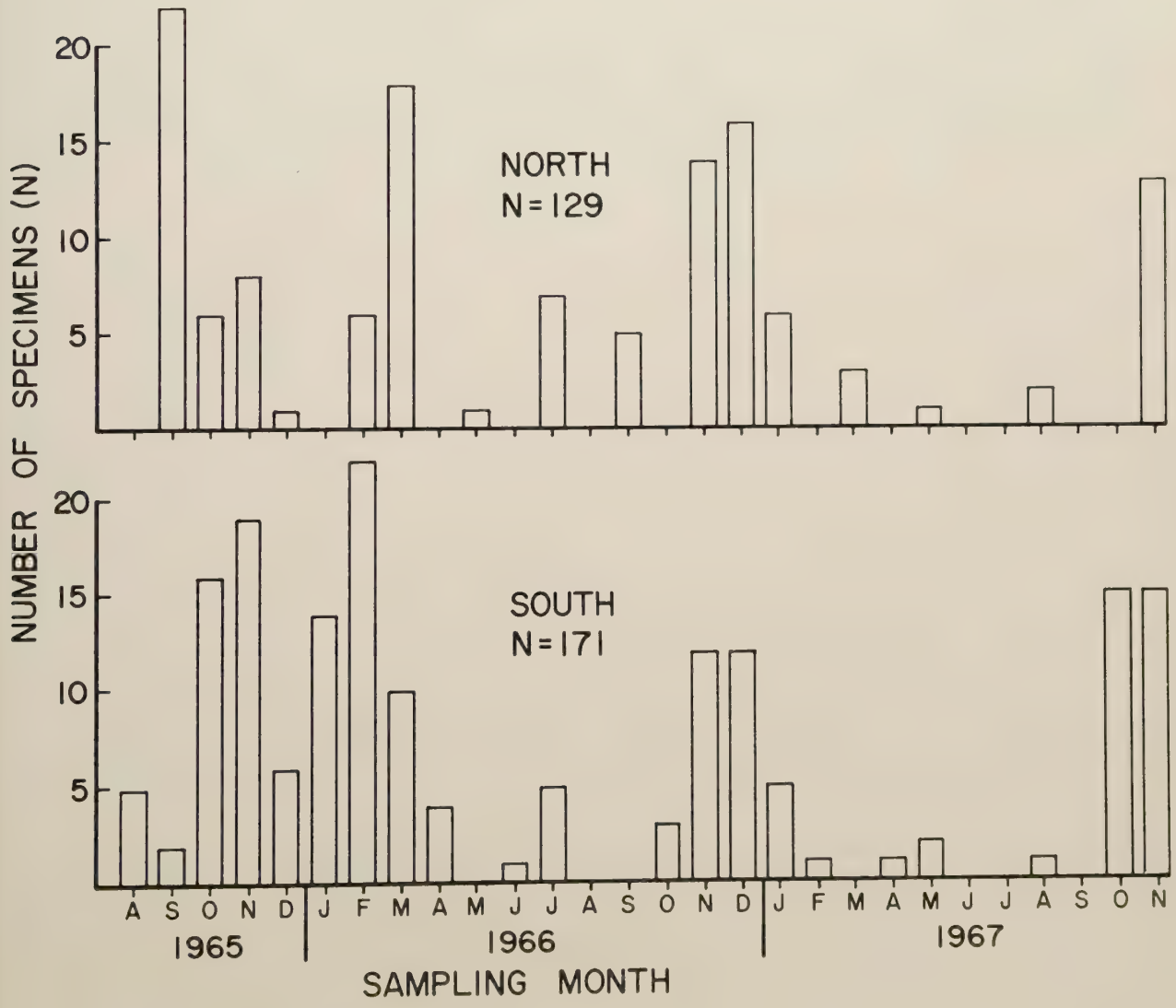


Figure 21. *Penaeus duorarum*: Intertransect monthly abundance during regular sampling.

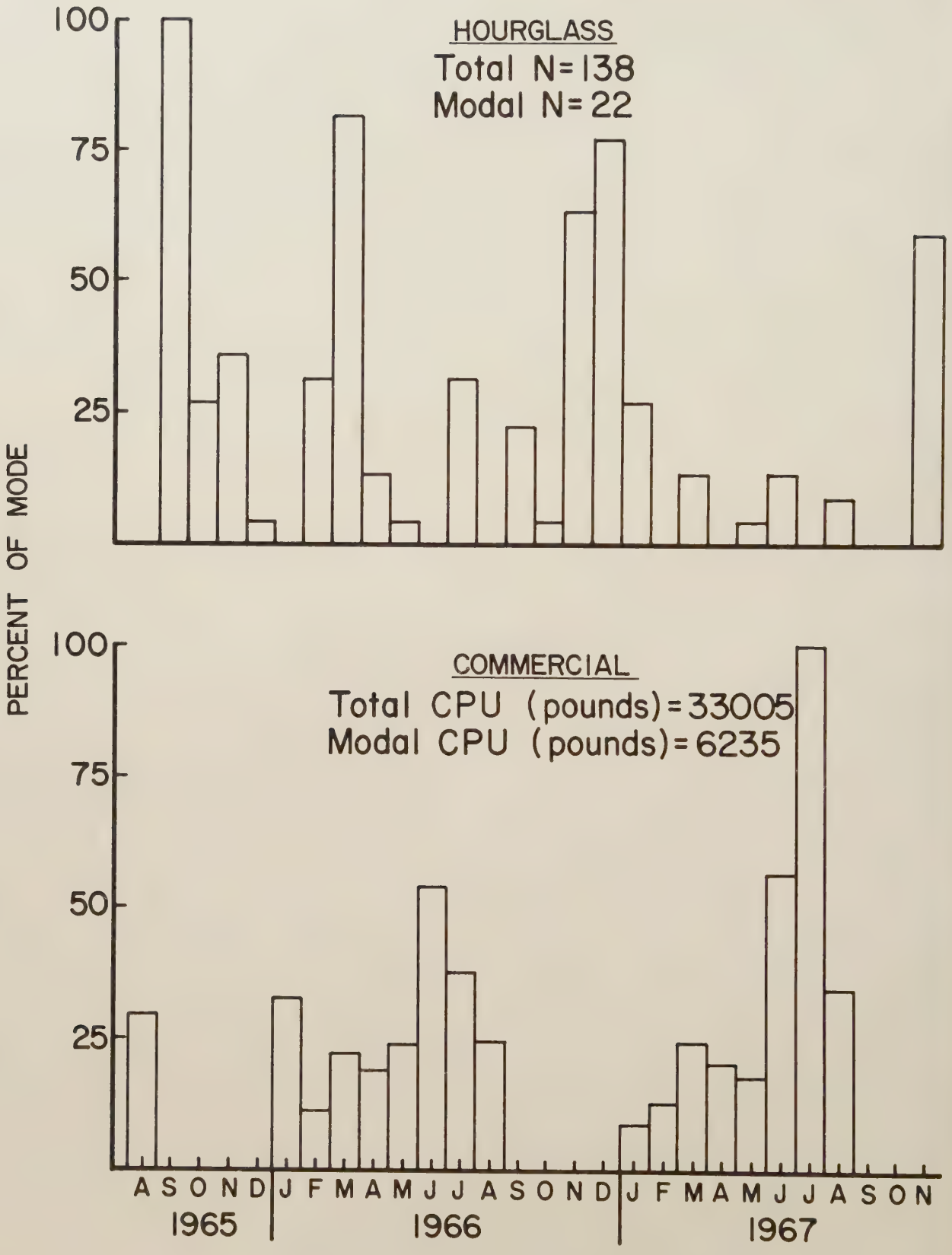


Figure 22. *Penaeus duorarum*: Monthly comparative catches between Hourglass sampling (north transect) and commercial landings (grid 5).

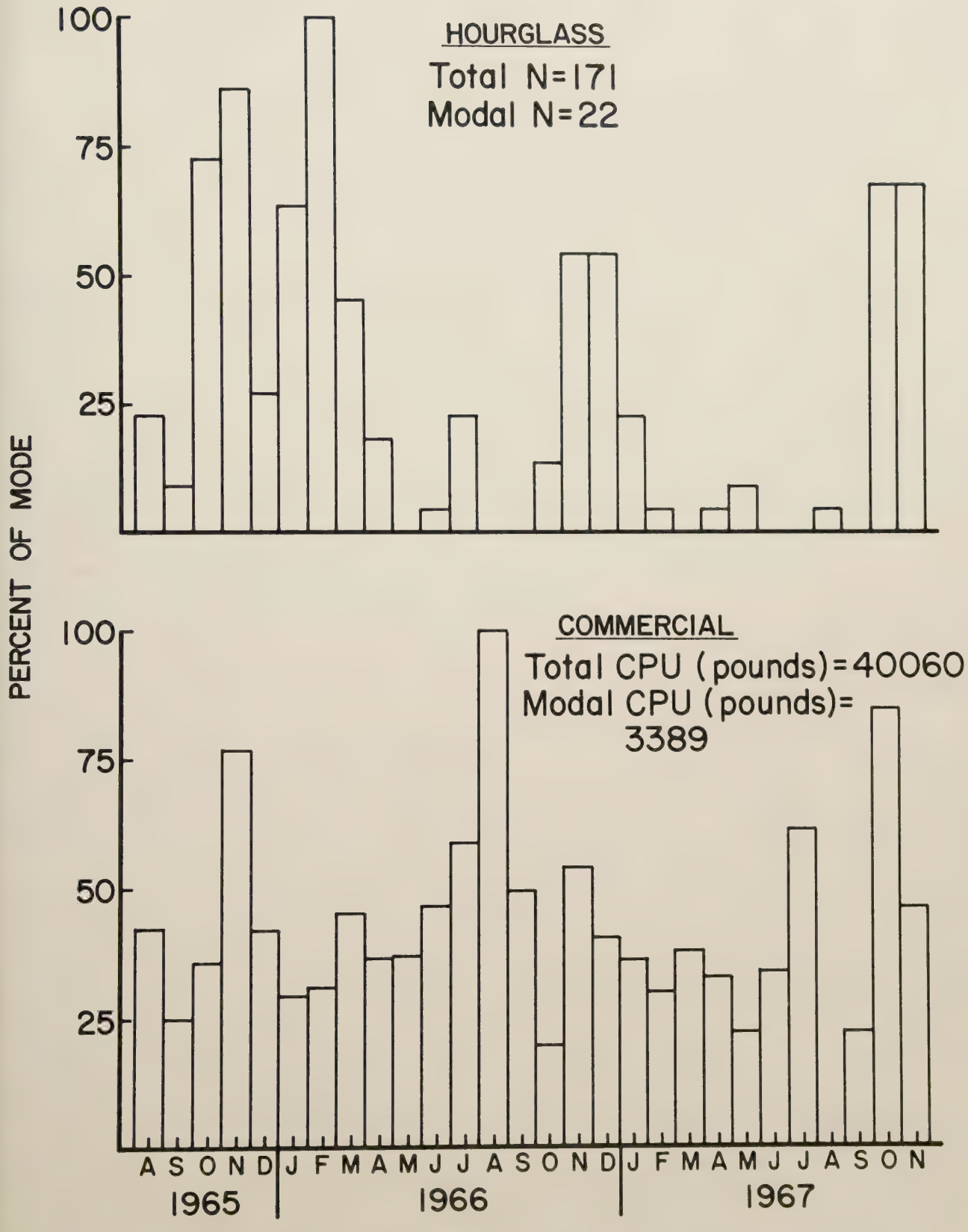


Figure 23. *Penaeus duorarum*: Monthly comparative catches between Hourglass sampling (south transect) and commercial landings (grid 4).

months (Joyce and Eldred, 1966); hence, peak occurrences in northern Hourglass sampling areas were unfished by local fleets.

Substantial commercial landings for southern areas close to the Hourglass transect were consistently maintained and were not correlated with Hourglass catches (Figure 23), the exploitable shrimp populations being concentrated outside the Hourglass study area (Costello and Allen, 1966: Fig. 1). Spawning is intense and protracted in the south, suggesting that this fishery is a ''steady state system'' with temperature related pulses of spawning and recruitment (Eldred et al., 1961). This pattern was supported by Roessler et al. (1969) and Jones et al. (1970).

Only nine specimens were caught during diurnal sampling. Adult *P. duorarum* are usually nocturnal, but when sufficiently stressed may become active and swim near the surface in daylight (Tabb et al., 1962a). Juveniles and adults may respond positively to low light levels (i.e., moonlight, extreme overcast). All commercial shrimping is done at night when shrimp are active.

Sixteen shrimp were caught by dredging, five of these in daylight. Dredging was relatively more successful than trawling for diurnal captures.

Some general trends representing two distinct recruitment patterns were evident from temporal changes in monthly size frequencies of Hourglass specimens. Major offshore recruitment began in October when modal length was smallest; such recruitment has also been reported in the more southern Tortugas populations (Eldred et al., 1961). The other recruitment pattern, typical of the more northern Tampa Bay population, was characterized by increased occurrence in March and April. These shrimp over-wintered in the bays, growing larger and not depressing modal lengths as they entered offshore populations. July populations appeared less structured and covered a wider length range, probably a mingling of recently recruited individuals and older offshore migrants (Eldred et al., 1961). January populations had smaller length ranges, reflecting a more recent estuarine origin of all individuals.

Growth, as inferred from length frequency, was most evident from October through March when the mean CL increased from 21.1 to 34.8 mm for males and from 22.4 to 40.5 mm for females (Figure 24). Costello and Allen (1970) summarized growth rates assessed by numerous authors, presenting the following: larvae - 0.38 mm TL (nauplii) to 4.1 mm TL (postlarvae) over a 2 to 3 week period; juveniles - 7 to 52 mm TL per month; adults - 0 to 22 mm TL per month.

Male/female ratio during the last 24 sampling months was 1.10; females predominated larger size classes (Figure 25). Heegaard (1972) speculated that most species of *Penaeus* were protandric hermaphrodites, a contention not supported in subsequent literature. We believe that greater mortality of males (Berry, 1970) was primarily responsible for declining ratios at longer lengths. An overall and characteristic sex ratio approaching unity has been well documented for this species (Pérez Farfante, 1969).

Stomach contents of 20 shrimp (25.0-51.5 mm CL) from night sampling (Stations B, February; C, November and January) and 10 shrimp (22.1-45.1 mm CL) from day sampling (B, November; J, December) were examined (Table 9). Twenty shrimp collected at night had stomachs at least 25% full and all shrimp caught during daylight had empty stomachs. Unidentifiable organic debris, sand and silt were in all stomachs. Bivalves, primarily *Lucina* sp., predominated stomach contents; small crustaceans (mainly amphipods), nematodes and foraminiferans occurred in a majority of stomachs. A cephalopod, *Loligo pleii* Blainville, 1823, was dominant in two stomachs. No plant material was found, although this food source was utilized by pink shrimp in other locations, particularly during estuarine portions of the life cycle (Eldred et al., 1961). Pérez Farfante (1969) summarized from other diet studies that *P. duorarum* is a benthic,

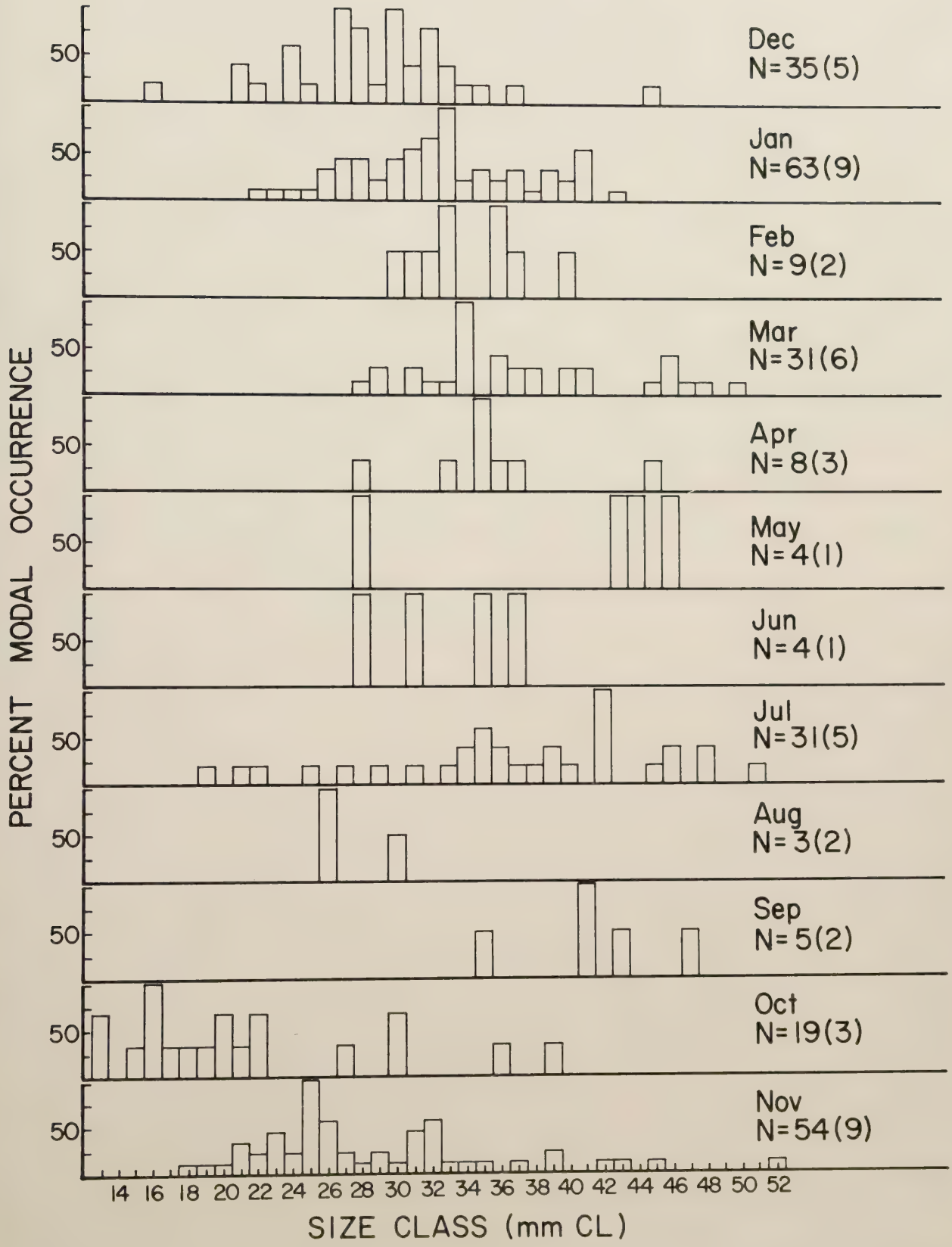


Figure 24. *Penaeus duorarum*: Combined monthly length frequencies for last 24 sampling months. 1 mm CL size classes, total N (modal N).

Figure 25. *Penaeus duorarum*: Cumulative male/female ratio for last 24 sampling months. 1 mm CL size classes.

TABLE 9. *Penaeus duorarum*: FOOD ITEM CONTENT AND COMPOSITION IN 22 STOMACHS.

Item	Predominant		Residual		Total	
	N	%*	N	%*	N	%*
Porifera spicules	0	—	1	5	1	5
Foraminiferida	0	—	12	60	12	60
Nematoda	0	—	12	60	12	60
Polychaeta	1	5	1	5	2	10
Mollusca						
Bivalvia	16	80	4	20	20	100
Gastropoda	1	5	5	25	6	30
Cephalopoda	2	10	0	—	2	10
Crustacea						
small	5	25	9	45	14	70
large	2	10	0	—	2	10
Echinoidea	0	—	1	5	1	5
Pisces	2	10	1	5	3	15
Empty					2	9**

*Percent of stomachs (20) containing food.
**Percent of stomachs (22) examined.

nocturnal omnivore. Additionally, our study revealed that pink shrimp were benthic, nocturnal carnivores during the continental shelf portion of their life cycle.

Only one *P. duorarum* (♂, 22.6 mm CL) was identified from fish stomachs. It was removed from a sand perch (*Diplectrum formosum*) trawled (night) at Station J during November 1966.

Genus *Trachypenaeus* Alcock, 1901

Trachypenaeus constrictus (Stimpson, 1871)

Figure 26

Penaeus constrictus Stimpson, 1871, p. 135; Kingsley, 1880, p. 427; Kingsley, 1899, p. 719

Parapenaeus constrictus: Smith, 1885, pp. 171, 174-178.

Trachypenaeus constrictus: Milne Edwards and Bouvier, 1909, pp. 232-235, figs. 60-63, pl. 5, figs. 7-10, pl. 6, figs. 1, 2; Pearson, 1939, pp. 2, 39-53, 71, figs. 32-45; Tabb and Manning, 1961, p. 595; Renfro and Brusher, 1963, p. 15; Holthuis and Rosa, 1965, p. 7; Lyons et al., 1971, p. 28; Brusher et al., 1972, pp. 75, 78-81, 83, 85; Wood, 1974, p. 39, pl. 6, figs. 3, 4; Brusher and Ogren, 1976, pp. 158, 161-165; Camp et al., 1977, pp. 24, 43, 46, 48; Christmas and Etzold, 1977, pp. 3, 5, 6, 14, 17; Livingston et al., 1977, p. 90; Pérez Farfante, 1978, 2 unnumbered pages, 5 unnumbered text-figs.

Trachypeneus constrictus: Burkenroad, 1934b, pp. 61, 94, 96-98, 100-102; Burkenroad, 1939, pp. 4, 5, 56; Anderson and Lindner, 1945, p. 314; Gunter, 1950, pp. 29, 30, 49; Hildebrand, 1954, pp. 267, 347; 1955, pp. 192, 220; Voss, 1955, pp. 8, 11, fig. 21; Wass, 1955, pp. 132, 142; Anderson, 1956, p. 4; Menzel, 1956, p. 41; Springer and Bullis, 1956, p. 9; Eldred, 1959, p. 3; Ingle et al., 1959, pp. 30, 31, 43; Eldred and Hutton, 1960, p. 101; Hulings, 1961, p. 217; Tabb et al., 1962a, pp. 7, 28; 1962b, pp. 61, 62; Saloman, 1964, p. 160; Bullis and Thompson, 1965, p. 7; Eldred et al., 1965, pp. 3, 26; Joyce, 1965, pp. 128-132, 162, 163, 220, 221; Williams, 1965, pp. 17, 31, 32, fig. 21; Joyce and Eldred, 1966, p. 25; Rouse, 1969, p. 136; Anderson, 1970, pp. 14-16, 19.

Material examined: HOURGLASS STATION A: 1♂, 3.4; 31 August 1966; dredge; FSBC I 8630. — 1♂, 3.2; 1♀, 5.8; 6 November 1966; dredge; FSBC I 8632. — 1♀, damaged; 1 August 1967; dredge; FSBC I 16632. — 2♀, 10.8, 10.9; 2 November 1967; trawl; FSBC I 8654. — HOURGLASS STATION B: 1♀, 16.7; 30 August 1965; trawl; FSBC I 836. — 1♀, 13.2; 30 August 1965; dredge; FSBC I 840. — 1♂, 45(TL); 1♀, 54(TL); 8 November 1965; trawl; discard. — 1♀, 63(TL); 8 November 1965; dredge; discard. — 1♀, 12.5; 3 January 1966; trawl; FSBC I 1536. — 1♂, 57(TL); 1♀, 73(TL); 2 May 1966; trawl; discard. — 1♀, 26(TL); 2 July 1966; dredge; discard. — 4♂, 26-36(TL); 9♀, 34-56(TL); 18 July 1966; trawl; discard. — 1♀, 25(TL); 31 August 1966; dredge; discard. — 1♀, 52(TL); 6 November 1966; dredge; discard. — 2♀, 14.2, 16.8; 1 December 1966; trawl; FSBC I 8637. — 3♂, 10.0-10.5; 1♂, damaged; 1♀, 9.0; 2♀, damaged; 3 damaged; 1 December 1966; trawl; stomach content; FSBC I 16675. — 1♀, 18.5; 6 January 1967; trawl; FSBC I 8640. — 1♀, 7.0; 5 October 1967; trawl; FSBC I 16635. — 2♂, 8.1, 11.2; 5 October 1967; dredge; FSBC I 8652. — 1♂, 9.1; 2 damaged; 2 November 1967; dredge; FSBC I 8655. — HOURGLASS STATION C: 1♀, 10.3; 6 November 1966; trawl; FSBC I 8633. — 1♀, 12.9; 13 December 1966; dredge; FSBC I 8639. — 1♀, 11.5; 1 damaged, 8.7; 2 March 1967; trawl; FSBC I 8645. — HOURGLASS STATION I: 1♀, 4.2; 12 October 1965; trawl; FSBC I 8625. — 1♂, 9.9; 5 July 1966; dredge; FSBC I 8627. — 1♂, 6.5; 5 August 1966; trawl; FSBC I 8629. — 1 damaged, 10.0; 4 September 1966; dredge; FSBC I 8631. — 1♂, 7.1; 2♀, 4.3, 4.5; 12 November 1966; trawl; FSBC I 8634. — 1♀, 2.9; 12 November 1966; dredge; FSBC I 8635. — 1♀, 14.6; 8 March 1967; trawl; FSBC I 8646. — 1♂, 3.2; 15 May 1967; dredge; FSBC I 8647. — 1♂, 3.5; 2 unsexed, 1.1, 1.8; 4 damaged, 2.6-3.8; 4 September 1967; dredge; FSBC I 8650. — 1♀, 2.3; 11 October 1967; dredge; FSBC I 8651. — HOURGLASS STATION J: 1, unsexed, unmeasured; 3 September 1965; trawl; discard. — 5♂, 6.5-9.5; 1♂, damaged; 12♀, 6.2-16.3; 1♀, damaged; 12 November 1965; trawl; FSBC I 1167. — 4♀, 12.0-17.4; 6 December 1965; trawl; FSBC I 1432. — 6♂, 9.2-12.5; 15♀, 11.3-17.1; 1♀, damaged; 14 February 1966; trawl; FSBC I 8626. — 13♀, 50-76(TL); 21 March 1966; trawl; discard. — 1♀, 4.5; 12 June 1966; dredge; FSBC I 16633. — 1♂, 3.0; 1♀, 3.0; 5 July 1966; dredge; FSBC I 16634. — 1♂, damaged; 28♀, 4.9-16.4; 21 July 1966; trawl; FSBC I 3427. — 1♀, damaged; 1 damaged, 8.0; 21 July 1966; trawl; stomach content; FSBC I 16674. — 1♂, 7.5; 1♀, 7.8; 1♀, damaged; 5 August 1966; trawl; stomach content; FSBC I 16673. — 2♀, 13.0, 14.2; 12 November 1966; trawl; FSBC I 8636. — 1♂, 9.7; 12 November 1966; trawl; stomach content; FSBC I 16672. — 1♂, 9.7; 2♀, 14.2, 15.2; 6 December 1966; trawl; FSBC I 8638. — 1♂, 10.0; 3♀, 10.1-19.0; 12 January 1967; trawl; FSBC I 8641. — 7♂, 9.7-12.2; 21♀, 9.0-19.0; 30 January 1967; trawl; FSBC I 8642. — 1♀, damaged; 15 February 1967; dredge; FSBC I 8644. — 1♀, 10.8; 11 October 1967; trawl; FSBC I

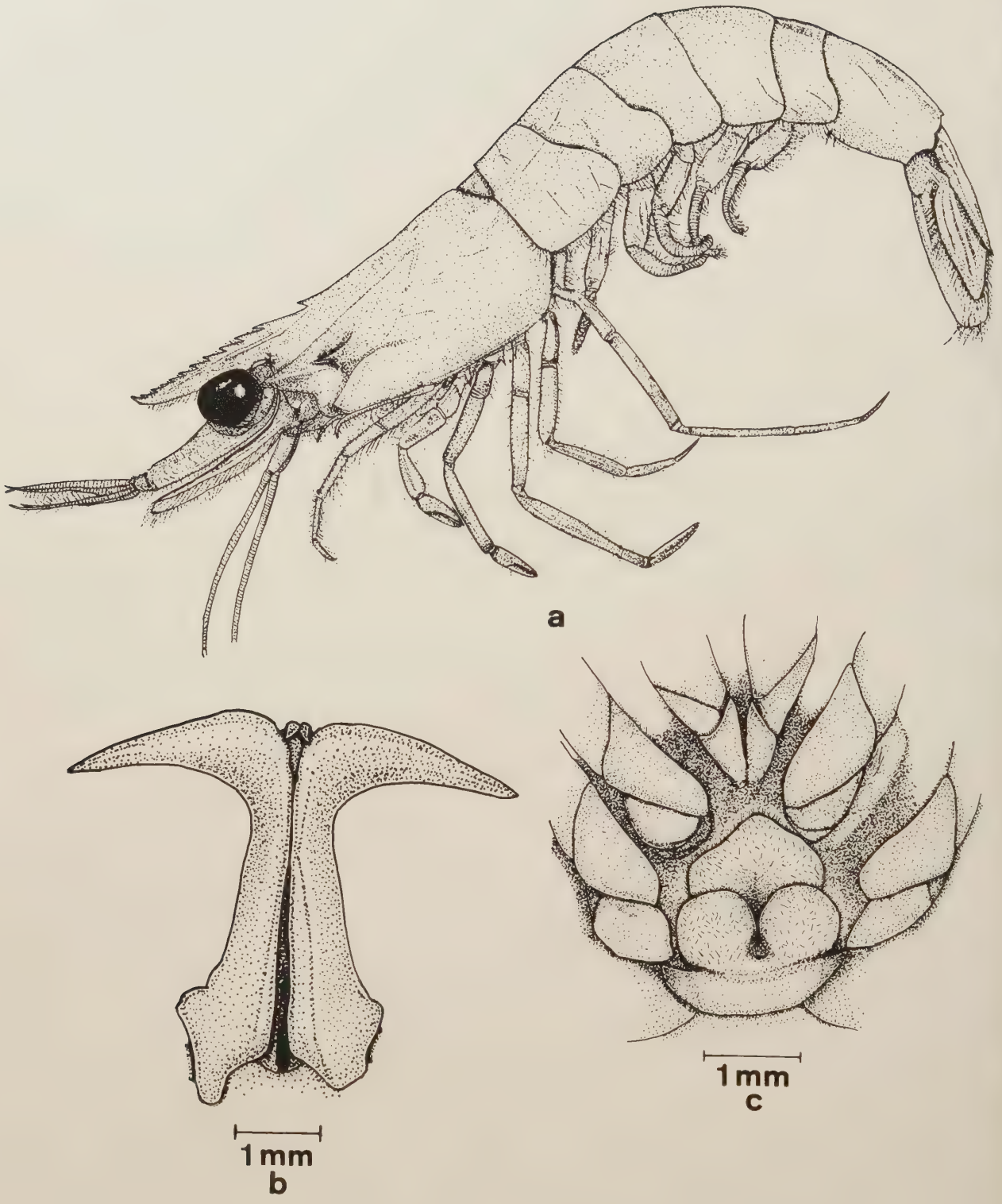


Figure 26. *Trachypenaeus constrictus*: a. ♀, 16.5 mm CL, surface setae omitted, FSBC I 16776; b. ♂, 11.2 mm CL, petasma, FSBC I 16776; c. ♀, 14.2 mm CL, thelycum, FSBC I 8636.

8653. — 4♀, 10.1-19.0; 14 November 1967; trawl; FSBC I 8656. — 1♀, 6.8; 1 damaged; 14 November 1967; dredge; FSBC I 8657. — HOURGLASS STATION K: 1♀, 34(TL); 13 October 1965; trawl; discard. — 1 damaged; 12 November 1965; trawl; discard. — 1♀, 28(TL); 12 June 1966; trawl; discard. — 1♀, 18.9; 30 January 1967; trawl; FSBC I 8643. — HOURGLASS STATION M: 1 damaged; 5 September 1966; dredge; FSBC I 17284. — 2♀, 11.2, 15.8; 5 September 1967; trawl; FSBC I 8649.

Diagnosis: Anterodorsal carapace pubescent, branchial region sparsely, almost imperceptibly pubescent. Narrow line of pubescence adjacent to dorsal carina of abdominal somites four, five, and six; carinal pubescence of fourth somite sometimes obscure, limited to posterior half of segment. Well developed orbital tooth, hepatic and antennal spines. Ventral surface of thelycum pubescent; lateral plates paddle-shaped, widely divergent at anteromedian corners. Males with sternal elevation between coxae of fifth pereopods goblet-shaped, constricted posteriorly.

Description: Carapace pubescence primarily anterodorsal to branchial region; setae more dense along hepatic carina, around hepatic spine, dorsal buttressing of antennal spine, and orbital region. Pubescence lacking on posterior branchial region.

Rostrum slender, nearly reaching level of base of third antennular segment, usually with eight equidistant dorsal teeth plus one epigastric tooth set posteriorly about twice distance between other teeth. Lateral carina of rostrum paralleled by smaller ventral carina forming a median sulcus, all merging anteriorly with tip. Postrostral carina becoming less distinct posteriorly, disappearing before posterior margin of carapace. Orbital tooth distinct; hepatic spine well developed; antennal spine buttressed. Hepatic carina extending anteroventrally, marking buttressing of antennal spine and blending with sulcus beneath hepatic spine. Sinuous, variously defined longitudinal sulcus on carapace extending from orbital margin posteriorly about two-thirds distance of carapace and dorsad of dorsal buttressing of antennal spine.

Eye stalk short, supporting large reniform eye. Prosartema not extending beyond distal ocular margin. Antennular peduncle extends to distal margin of ciliated scaphocerite. Cylindrical antennular flagella similar in length, about 0.7 length of peduncle. Lateral marginal spines of scaphocerite not exceeding distal margin of scaphocerite, distinctly separated distally. Length of scaphocerite about three times maximum width.

Third maxilliped exceeding carpocerite by length of own dactyl; exopod extending beyond base of carpus of maxilliped. First pereopod extending to base of carpocerite. Second pereopod extending to base of antennal flagellum. Third pereopod exceeding base of antennal flagellum by length of own prodopus. Fourth pereopod just exceeding basicerite. Fifth pereopod exceeding base of antennal flagellum by length of own prodopus. Exopod of fifth pereopod exceeding distal end of basis. Basis of third maxiliped, first and second pereopods armed with single slender spines.

Last three abdominal somites carinate. Posterodorsal carina of fourth and fifth somites split to accommodate anterodorsal carina of next posterior somite; posterodorsal carina of sixth somite produced into a tooth. Narrow line of pubescence along base of carina of fourth, fifth, and sixth somites; pubescence of fourth somite much less distinct, found only on posterior half of carina. Telson pubescent, with two dorsolateral carinae forming dorsomedian sulcus, blending posteriorly into moderate tip. Telson tip flanked by stout pair of subterminal spines proceeded by another smaller pair of stout, stiffly articulated spines. Mesial ramus of uropod exceeding telson tip; lateral ramus exceeding mesial; lateral ramus with small submarginal tooth.

Lateral plates of thelycum paddle shaped, divergent at anteromedian corners, overlapping median process forming transverse groove; mesial separation of lateral plates, uniting posteriorly at low transverse

ridge of somite XIV. Median process subtriangular, with anteromedial margin produced into obtuse curved angle bearing setae on margin. Median process deeply concave, pubescent; ventral surface of lateral plates pubescent.

Petasma with ventral costa divergent distally, curving laterally into flattened, horn-like projections tapering dorsoventrally. Distomedian projections visible at divergence of ventral costa. Club-like appendix masculina with ventromesially directed setae on margin, ventral and dorsal surfaces glabrous. Sternal elevation between coxae of fifth pereopods constricted posteriorly, goblet-shaped.

Geographic and bathymetric range: Tangier Sound, Nova Scotia; Chesapeake Bay, Virginia, southward and through Gulf of Mexico; Bermuda; Cuba; Caribbean Sea and south to Santa Catarina Island, Brazil (26° 53′S). Shallow water to 91 m.

Remarks:Two hundred three *T. constrictus* (2.3-19.0 mm CL) were caught during Hourglass sampling (Table 10); an additional 16 specimens were recovered from fish stomachs. This species was disproportionately distributed between transects, being 3.5 times more abundant on the southern transect. However, occurrences were most frequent at 18 m stations (Figure 27) along both transects.

Trachypenaeus constrictus has been observed in commercial catches of *Xiphopenaeus kroyeri* off Brazil (Mistakidis and Neiva, 1964) and in commercial pink shrimp landings from the Campeche Bank (Hildebrand, 1955). This species and its congener, *T. similis*, commonly occurred in Tortugas pink shrimp landings (Eldred, 1959). However, *T. constrictus* and *T. similis* tend to segregate in other areas of the Gulf; Burkenroad (1939) found discreet populations of *T. similis* in Pensacola Bay, Florida and *T. constrictus* just offshore. A similar segregated distribution was observed by Brusher and Ogren (1976) for the St. Andrew Bay system, Florida. Hildebrand (1954) found *Trachypenaeus similis* exclusively in western Gulf brown shrimp catches and a small unique collection was reported from the mouth of Tampa Bay (Saloman, 1964). Presently, *T. constrictus* is often found in Tampa Bay, generally associated with the pink shrimp bait fishery.

TABLE 10. *Trachypenaeus constrictus*: MONTHLY OCCURRENCES AT HOURGLASS STATIONS. TRAWL CAPTURES (TOP NO.), DREDGE CAPTURES (BOTTOM NO.).

Trachypenaeus constrictus

STA	1965					1966													1967											TOT
	A	S	O	N	D	J	F	M	A	M	J	J	J sp	A	S	O	N	D	J	J sp	F	M	A	M	J	J	A	S	O	N	
A															1		2													2	2
																															4
B_1		1		2		1				2		1	13		1		1	2	1								1		1		23
		1		1													1												2	3	10
B_2																															
C_1																	1					2									3
C_2																		1													1
D_1																															
D_2																															
E																															
I			1									1		1		1	3					1									6
																	1							1				7	1		12
J		1		19	4		22	13			1	2	29				2	3	4	28	1								1	4	129
K			1	1							1									1										2	6
																															4
L																															
M															1													2			2
																															1
TOT		2	2	22	4	1	22	13		2	1	4	42	1	4		6	5	5	29	1	3		1			1	2	2	6	169
		1		1							1						4	1										7	3	5	34

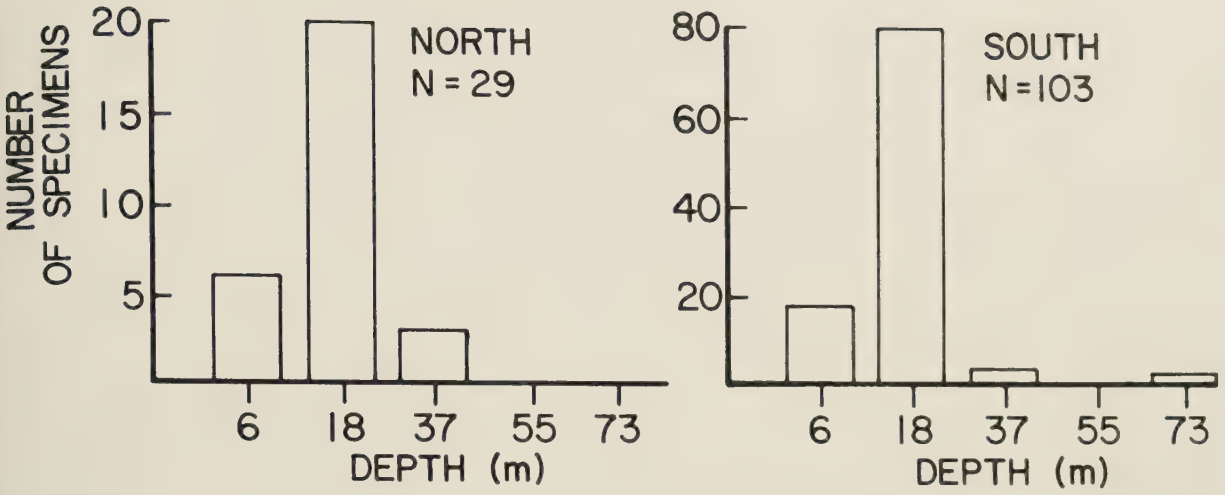


Figure 27. *Trachypenaeus constrictus*: Abundance at stations on north and south transects during regular sampling.

This shrimp is euryhaline, but with an apparent preference for higher salinities (Burkenroad, 1939; Gunter, 1950). Rouse (1969) reported the widest salinity range (15-45 ‰), but encountered most specimens in 29-37 ‰. Combined salinities for Hourglass Stations B and J where most specimens were caught were 30.24-36.26 ‰. Previously reported temperatures ranged from 13.3 to 30.0°C. In this study, *T. constrictus* was found at temperatures ranging from 16.4 to 31.0° C.

Burkenroad (1939) correctly speculated that this shrimp prefers a sand substrate. It was the most abundant penaeoid caught during a faunal survey off Hutchinson Island, Florida, where it was found only over sand or sand-shell (Camp et al., 1977). Off St. Andrew Bay, most *T. constrictus* were caught over sediments consisting of 80% sand (Brusher and Ogren, 1976). Sediments at 18 m stations of Project Hourglass were chiefly terrigenous sand or sand-shell. However, *T. constrictus* has been reported from virtually all other characterized substrates ranging from peaty marl to exposed limestone outcroppings.

No distinct seasonal occurrence patterns were apparent from Hourglass sampling (Figure 28). November was the peak abundance month for all three years on the northern transect, but there were no correlated peaks off Sanibel Island, possibly because of year-round recruitment that may occur there (see discussion on reproduction).

Only one specimen was caught during day sampling. This was dredged at Station C in December. Joyce (1965) found *T. constrictus* almost equally abundant during day and night in northeast Florida; 56% were caught at night. Similarly, Brusher et al., (1972) concluded that it "may be equally available to day and night trawl tows" offshore of Louisiana and Texas. This species was captured only at night at Hutchinson Island (Camp et al., 1977) and in the St. Andrew Bay system (Brusher and Ogren, 1976).

Thirty-four (26% of regular sampling) specimens were caught by dredging. Dredges were twice as effective as trawls at Stations A and I (6 m).

Size of Hourglass specimens ranged from 1.1 to 19.0 mm CL. Sample size was too small in several months to allow growth inferences from length frequencies (Figure 29). Joyce (1965) estimated growth based on modal progression over a five month period to average slightly above 6 mm TL per month. Small

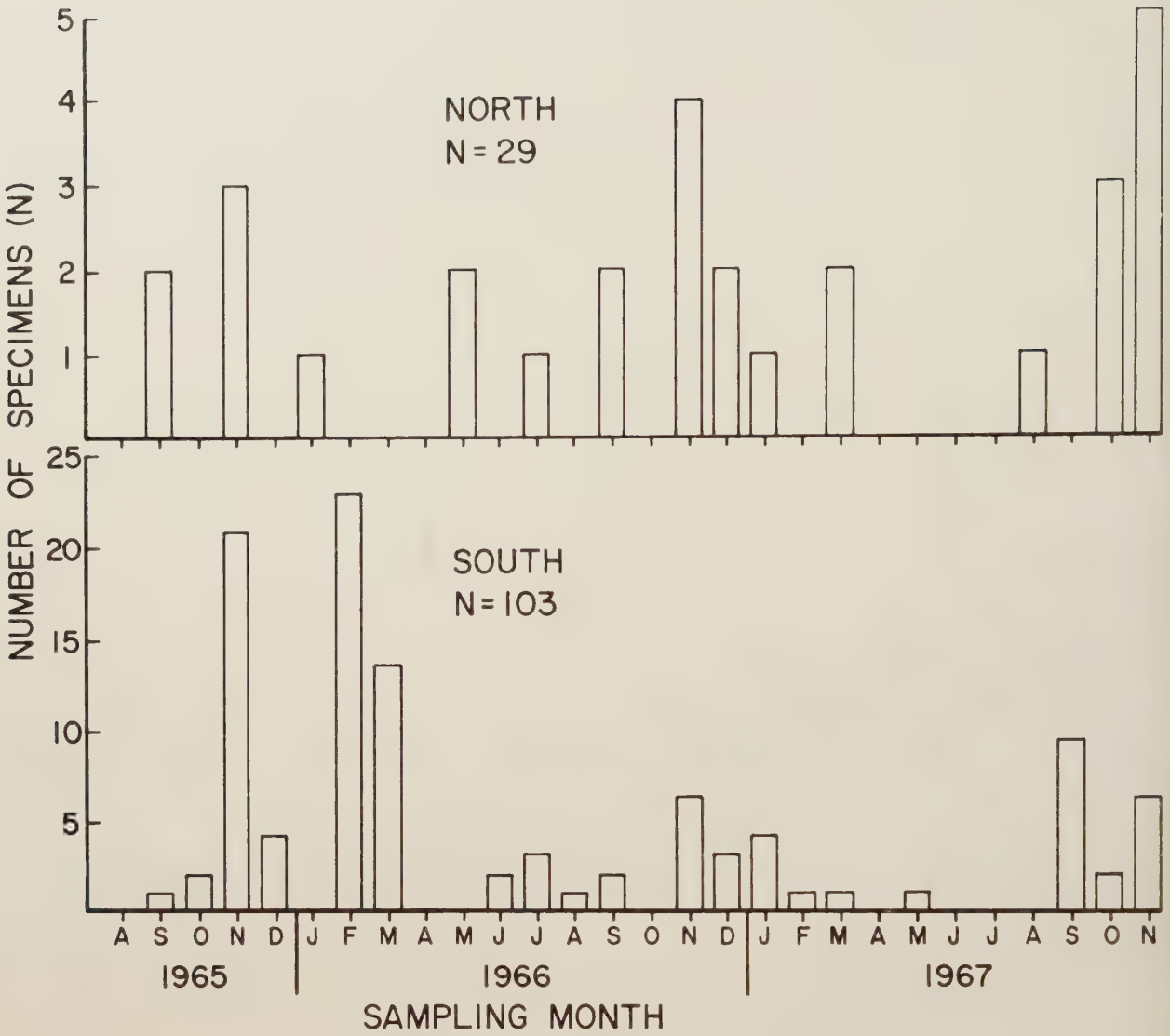


Figure 28. *Trachypenaeus constrictus*: Intertransect monthly abundance during regular sampling.

Hourglass specimens (≤5.4 mm CL) were caught from May through November (except August when only one 6.5 mm CL shrimp was captured). No progression of modal size was observed.

Male/female ratio of sexed *T. constrictus* was 0.28. Eldred et al. (1965) reported a 0.23 ratio offshore of Tampa Bay. In northeast Florida, Joyce (1965) noted a 0.35 ratio inshore (trawl stretch mesh = 2.9 cm) and 0.14 offshore (trawl stretch mesh = 5.1 cm) where shrimp were larger (average ratio = 0.24). At Hutchinson Island, Camp et al. (1977) reported a 0.30 sex ratio. Brusher et al. (1972) reported a 0.05 ratio from depths of 14 and 27 m off Louisiana and Texas; all *T. constrictus* they caught (trawl stretch mesh = 5.1 cm) were greater than 56 mm TL, but no males larger than 70 mm TL were found and 95% of females were larger than 70 mm TL. Joyce (1965) found that 70 to 100% of the northeast Florida population above 35 mm TL were female. Forty-three percent of females during the last 24 months of Hourglass sampling were larger than the largest male (13.2 mm CL). Sex ratio for 12 of 16 specimens recovered from Hourglass fish

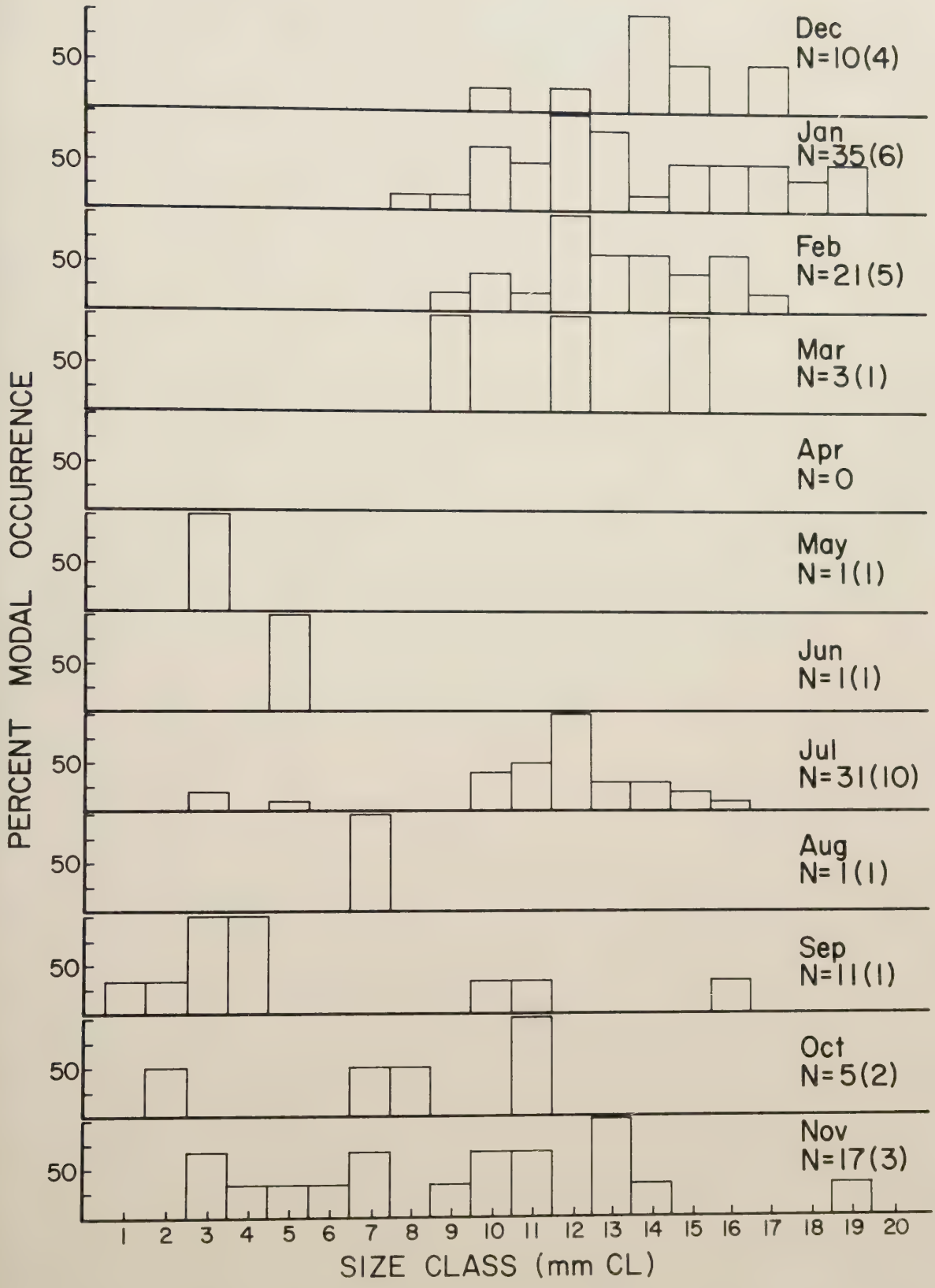


Figure 29. *Trachypenaeus constrictus*: Combined monthly length frequencies for last 24 sampling months. 1 mm CL size classes, total N (modal N).

stomachs was 1.00; sex could not be determined for the other four specimens. Gear selectivity may have affected ratios, but the general penaeoid pattern of females dominating larger size classes and possibly outliving males seems characteristic of this species.

Pearson (1939) conducted sampling for planktonic penaeoid eggs and larvae off St. Augustine and Ft. Pierce, Florida, one to three times per week for over a year. He concluded that spawning occurred "over the warm months of the year" near St. Augustine and year-round off Ft. Pierce. Joyce (1965) reported peak abundance of impregnated females in the same area in April and May; first recruits appeared in June. He also reported a possible second spawning in October and November. Off Georgia and South Carolina, Anderson (1970) reported an early spring to summer spawning season. Ripe females were encountered in June and September off Aransas Pass, Texas (Gunter, 1950). Rouse (1969) recorded *T. constrictus* larvae year-round in Shark River in extreme southwest Florida.

No gonads of Hourglass specimens were examined. However, females with attached spermatophores were encountered in December (22% of females captured in that month), January (52%), February (80%), July (76%), October (33%) and November (28%). These occurrences and absence of definite pulses of juvenile recruitment indicate extended, possibly year-round spawning in the Hourglass study area.

Stomachs of fourteen *T. constrictus* (12.1-16.8 mm CL) from night sampling (Station J, July) were examined. Nine stomachs were 100% full, and one was empty (Table 11). Crustaceans, bivalves and polychaetes were equally present in stomach contents. The operculum of a gastropod, *Natica* sp. was found in one stomach. Taxonomic categories were difficult to discern because stomach contents were fragmented, most containing finely triturated matter consisting of sand and organic debris. Consequently, *T. constrictus* appears to be a generalized benthic carnivore.

Trachypenaeus constrictus was recovered from stomachs of three fish species. At Station J, four specimens were found in stomachs of two sand perch (*Diplectrum formosum*) and two were examined from the stomach of a lane snapper (*Lutjanus synagris*, Linné, 145 mm SL). A sea robin (*Prionotus salmonicolor* Fowler) captured at Station B had ten *T. constrictus* in its stomach.

TABLE 11. *Trachypenaeus constrictus*: FOOD ITEM CONTENT AND COMPOSITION IN 14 STOMACHS.

Item	Predominant		Residual		Total	
	N	%*	N	%*	N	%*
Foraminiferida	0	—	1	8	1	8
Polychaeta	5	38	2	15	7	53
Mollusca						
Unidentifiable fragments	0	—	1	8	1	8
Bivalvia	5	38	3	23	8	61
Gastropoda	1	8	0	—	1	8
Crustacea						
Unidentifiable fragments	5	38	3	23	8	61
Empty					1	7**

*Percent of total stomachs (13) containing food.
**Percent of total stomachs (14) examined.

Family Sicyoniidae Ortmann, 1898
Genus *Sicyonia* H. Milne Edwards, 1830

Sicyonia brevirostris Stimpson, 1871

Figure 30

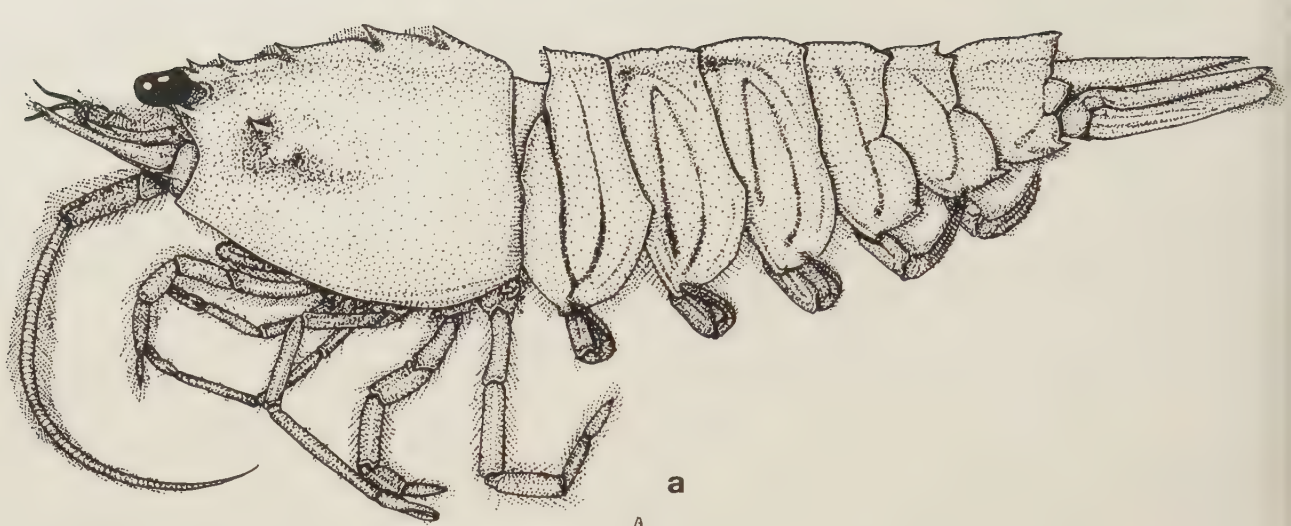
Sicyona cristata: de Saussure, 1857, p. 306 [erroneous spelling of *Sicyonia*; not *Sicyonia cristata* de Haan, 1850, *fide* Cobb et al., 1973].

Sicyonia cristata: de Saussure, 1858, p. 55, pl. 3, fig. 25 [not *Sicyonia cristata* de Haan, 1850, *fide* Cobb et al., 1973].

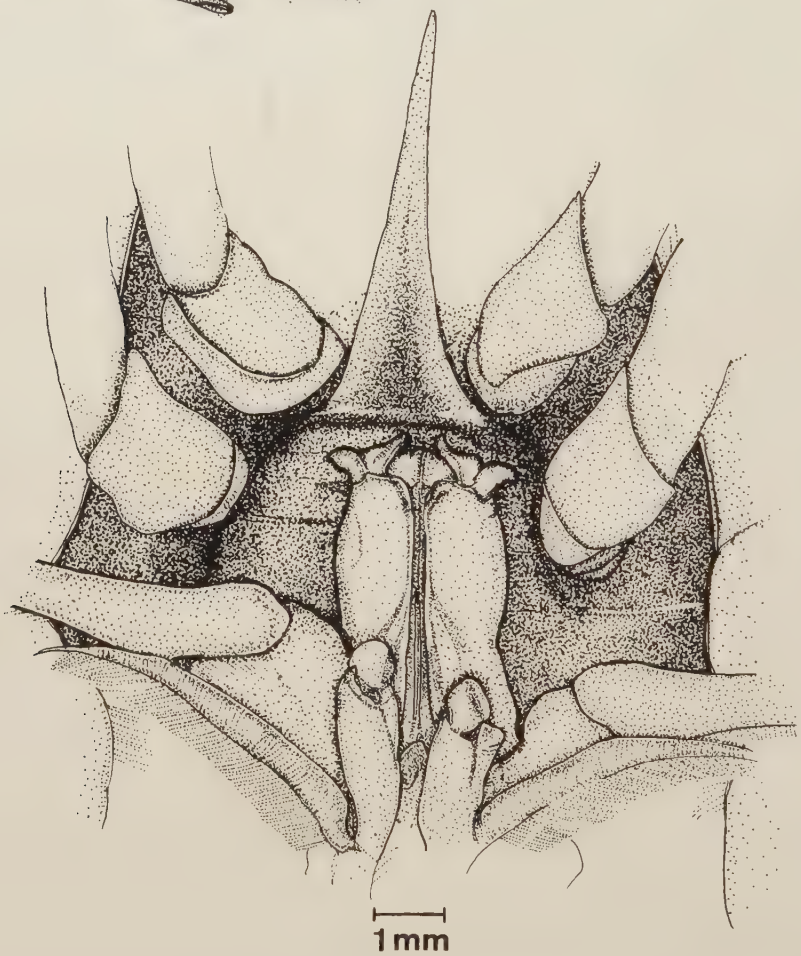
Sicyonia brevirostris Stimpson, 1871, p. 132 [*nomen substitutum*]; Faxon, 1896, p. 162; Kingsley, 1899, p. 719; Milne Edwards and Bouvier, 1909, pp. 245-250, figs. 72-83, pl. 7, figs. 1-16; Hildebrand, 1954, pp. 268-270, 325; 1955, pp. 192, 220; Voss, 1955, p. 11, fig. 24; Wass, 1955, pp. 132, 143; Menzel, 1956, p. 41; Springer and Bullis, 1956, p. 10; Lunz, 1957, pp. 4-9, 2 text-figs.; Eldred, 1959, p. 5; Eldred and Hutton, 1960, p. 112, fig. 14; Hulings, 1961, pp. 217, 219; Cook, 1963, pp. 28, 29; Renfro and Brusher, 1963, p. 15; Joyce, 1965, pp. 132, 164, 165, 190, 192, 220, 221; Eldred et al., 1965, p. 32; Bullis and Thompson, 1965, p. 7; Cook and Murphy, 1965, pp. 109-127; Holthuis and Rosa, 1965, p. 7; Williams, 1965, pp. 33, 35, 36, figs. 25, 26; Joyce and Eldred, 1966, pp. 24, 25; Rouse, 1969, p. 136; Subrahmanyam, 1971a, pp. 256, 257; 1971b, p. 317; Brusher et al., 1972, pp. 75, 77-82; Franks et al., 1972, p. 54; Cobb et al., 1973, 38 pp., figs. 3, 4, 8, 9, 13; Wood, 1974, p. 40, pl. 8, fig. 3; Bryan and Cody, 1975a, pp. 1-11; 1975b, p. 24; Brusher and Ogren, 1976, pp. 158, 161-165; Camp et al., 1977, pp. 23, 46, 48; Christmas and Etzold, 1977, pp. 3, 5, 6, 14, 16, 17, 45; Kennedy et al., 1977, 69 pp.; Pérez Farfante, 1978, 2 unnumbered pages, 3 unnumbered text-figs.

Eusicyonia brevirostris: Burkenroad, 1934a, pp. 73, 84-86, 105; 1934b, p. 117; 1939, p. 57; Anderson and Lindner, 1945, p. 317; Lunz, 1945, pp. 4, 6, 7, 11, fig. 3; Anderson, 1956, pp. 2, 4; Bullis and Rathjen, 1959, pp. 19, 20.

Material examined: HOURGLASS STATION B: 1 unsexed, unmeasured; 26 August 1965; dredge; discard. — 1♀, 33.5; 8 November 1965; trawl; FSBC I 1118. — 1♂, 26.1; 3 December 1965; trawl; FSBC I 1336. — 2♂, 15.4, 18.5; 1♂, damaged; 2♀, 18.7, 22.3; 2 damaged; 7 February 1966; trawl; FSBC I 7487. — 1♂, 13.8; 3 March 1966; trawl; FSBC I 7548. — 2♂, 18.0, 21.1; 2 July 1966; trawl; FSBC I 7499. — 1♂, 10.2; 18 July 1966; trawl; FSBC I 7502. — 1♀, 14.7; 18 July 1966; trawl; stomach content; FSBC I 16660. — 1♀, 10.7; 27 February 1967; dredge; FSBC I 7479. — HOURGLASS STATION C: 1 unsexed, unmeasured; 26 August 1965; dredge; discard. — 15 unsexed, unmeasured; 31 August 1965; trawl; discard. — 1 unsexed, unmeasured; 31 August 1965; dredge; discard. — 1♀, 12.1; 5 October 1965; trawl; FSBC I 910. — 1 unsexed, 46(TL); 5 October 1965; dredge; discard. — 2♂, 12.6, 18.2; 4♀, 11.2-16.3; 8 November 1965; trawl; FSBC I 1131. — 2♂, 14.1, 18.1; 2♀, 22.4, 25.2; 1 damaged; 3 January 1966; trawl; FSBC I 1556. — 1♀, 17.8; 7 February 1966; trawl; FSBC I 1925. — 5♂, 11.3-22.0; 1♂, damaged; 10♀, 12.7-26.2; 3 March 1966; trawl; FSBC I 7493. — 1♂, 16.9; 1 damaged; 16 April 1966; trawl; FSBC I 7557. — 2♀, 13.1, 18.2; 2 May 1966; trawl; FSBC I 7506. — 1♀, 18.0; 6 June 1966; trawl; FSBC I 7512. — 1♂, 17.0; 18 June 1966; trawl; FSBC I 7541. — 1♀, 74(TL); 18 June 1966; trawl; discard. — 9♂, 11.9-24.5; 2♀, 6.9, 25.9; 2 July 1966; trawl; FSBC I 7463. — 1♂, 34(TL); 11 July 1966; dredge; discard. — 4♂, 9.2-23.4; 3♀, 20.4-23.9; 1♀, damaged; 11 July 1966; dredge; FSBC I 7553. — 30♂, 11.7-29.8; 37♀, 11.6-28.4; 3 damaged; 18 July 1966; trawl; FSBC I 3342. — 2♂, 14.1, 17.0; 2♀, 9.0, 30.5; 1 August 1966; trawl; FSBC I 7504. — 1♂, 16.6; 1♀, 13.0; 11 August 1966; trawl; FSBC I 7470. — 22♂, 8.3-23.4; 1♂, damaged; 28♀, 10.0-27.7; 2♀, damaged; 31 August 1966; trawl; FSBC I 3953. — 1♀, 30.6; 31 August 1966; dredge; FSBC I 7524. — 1 damaged; 31 August 1966; trawl; stomach content; FSBC I 17297. — 2 damaged, 14.0, 6.0; 31 August 1966; trawl; stomach content; FSBC I 17298. — 1♂, 8.3; 1♀, 18.7; 8 September 1966; trawl; FSBC I 7527. — 2♂, 15.4, 21.2; 2♀, 12.9, 14.0; 8 October 1966; trawl; FSBC I 7464. — 1♀, 31.1; 18 October 1966; trawl; FSBC I 7538. — 9♂, 18.4-23.4; 23♀, 11.2-28.2; 6 November 1966; trawl; FSBC I 7610. — 2♂, 16.8, 17.0; 3♀, 20.1-29.0; 1 December 1966; trawl; FSBC I 7053. — 1♀, 8.0; 1 December 1966; trawl; stomach content; FSBC I 16659. — 9♂, 18.6-22.9; 10♀, 18.7-22.6; 1 damaged, 19.7; 6 January 1967; trawl; FSBC I 7615. — 6♂, 12.1-23.1; 15♀, 13.0-26.2; 1♀, damaged; 25 January 1967; trawl; FSBC I 7617. — 1♀, 18.7; 5 February 1967; trawl; FSBC I 7520. — 2♂, 19.1, 19.7; 2♀, 19.7, 25.9; 2 March 1967; trawl; FSBC I 7495. — 3♂, 15.1-21.9; 3 April 1967; trawl; FSBC I 7516. —



a



b

Figure 30. *Sicyonia brevirostris*: a. ♀, 28.3 mm CL, FSBC I 18973; b. ♂, 17.4 mm CL, petasma, FSBC I 15623. Surface setae omitted.

1♂, 17.6; 2 June 1967; trawl; FSBC I 7521. — 4♀, 17.8, 20.1; 21 June 1967; dredge; FSBC I 7522. — 1♀, 12.7; 1 July 1967; dredge; FSBC I 6650. — 1♂, 17.5; 11 July 1967; trawl; FSBC I 7536. — 1♀, 13.7; 1 August 1967; trawl; FSBC I 7519. — 3♂, 11.8-19.5; 11 August 1967; trawl; FSBC I 7564. — 1♂, 24.8; 1♀, 20.8; 11 August 1967; dredge; FSBC I 7549. — 1♂, 19.8; 1♀, 17.4; 5 October 1967; trawl; FSBC I 7511. — 1♀, 3.5; 5 October 1967; dredge; FSBC I 16625. — 1♂, 24.6; 25 October 1967; dredge; FSBC I 7528. — 6♂, 12.0-30.2; 8♀, 8.0-31.5; 2 November 1967; trawl; FSBC I 7611. — HOURGLASS STATION D: 1 unsexed, unmeasured; 3 August 1965; trawl; discard. — 3 unsexed, unmeasured; 27 August 1965; trawl; discard. — 1 unsexed, unmeasured; 27 August 1965; dredge; discard. — 1 unsexed, unmeasured; 31 August 1965; trawl; discard. — 3 unsexed, 59-91(TL); 5 October 1965; trawl; discard. — 1♂, 27.4; 1♀, 31.8; 21 October 1965; trawl; FSBC I 980. — 2♂, 24.4, 31.0; 9 November 1965; trawl; FSBC I 1136. — 3♂, 19.5-21.1; 3♀, 12.0-33.9; 4 December 1965; trawl; FSBC I 1372. — 1♂, 10.1; 2♀, 12.7, 12.9; 4 January 1966; trawl; FSBC I 2000. — 2♀, 30.5, 31.5; 8 February 1966; dredge; FSBC I 1938. — 4♂, 12.0-29.4; 1♀, 23.9; 4 March 1966; trawl; FSBC I 7471. — 1♂, 11.0; 27 March 1966; trawl; FSBC I 7545. — 1♂, 17.1; 1♂, damaged; 3♀, 12.0-15.7; 7 April 1966; trawl; FSBC I 7547. — 1♂, 13.0; 3 May 1966; trawl; FSBC I 7526. — 1♀, 28.0; 3 May 1966; dredge; discard. — 1♂, 17.9; 3♀, 14.5-25.6; 1♀, damaged; 7 June 1966; trawl; FSBC I 7540. — 1♀, 15.1; 18 June 1966; trawl; FSBC I 7546. — 1♂, damaged; 2♀, 11.4, 14.8; 3 July 1966; trawl; FSBC I 7537. — 4♂, 12.0-25.4; 6♀, 8.0-32.0; 11 July 1966; trawl; FSBC I 3360. — 1♀, 24.5; 11 July 1966; dredge; FSBC I 7534. — 26♂, 14.4-26.3; 24♀, 11.6-38.0; 19 July 1966; trawl; FSBC I 3347. — 1♀, 19.6; 2 August 1966; trawl; FSBC I 15618. — 1♂, 14.9; 11 August 1966; trawl; FSBC I 15619. — 1♂, 52(TL); 1♀, 71(TL); 11 August 1966; trawl; discard. — 1 unsexed, 4.5; 11 August 1966; dredge; FSBC I 8983. — 2♂, 13.1, 27.1; 6♀, 9.0-28.8; 1 September 1966; trawl; FSBC I 15620. — 2♀, 24.2, 32.1; 1 September 1966; dredge; FSBC I 7472. — 5♂, 19.6-29.2; 5♀, 13.8-25.1; 9 October 1966; trawl; FSBC I 7490. — 1♀, 14.0; 9 October 1966; trawl; stomach content; FSBC I 16658. — 1♂, 18.1; 1♂, damaged; 1♀, 25.2; 9 October 1966; dredge; FSBC I 15622. — 4♂, 16.9-25.8; 4♀, 15.1-29.6; 9 November 1966; trawl; discard. — 1♀, 13.7; 9 November 1966; dredge; FSBC 16656. — 4♂, 19.1-27.4; 20 November 1966; trawl; FSBC I 7551. — 1♂, damaged; 1♀, 31.1; 2 December 1966; trawl; FSBC I 7481. — 1♂, damaged; 2 December 1966; trawl; stomach content; FSBC I 16657. — 2♂, 20.4, 23.3; 3♀, 24.9-30.1; 7 January 1967; trawl; FSBC I 15606. — 1♀, 32.0; 7 January 1967; dredge; discard. — 1♂, 26.0; 1♀, 14.6; 1 damaged; 26 January 1967; trawl; FSBC I 15608. — 1♀, 30.3; 6 February 1967; trawl; FSBC I 15610. — 1♂, 26.3; 3 March 1967; trawl; FSBC I 15611. — 1♀, 4.1; 3 March 1967; trawl; stomach content; FSBC I 7051. — 1♀, 12.2; 4 April 1967; trawl; FSBC I 6652. — 2♂, 12.2, 28.9; 1♀, 10.5; 12 May 1967; trawl; FSBC I 15612. — 1♀, 3.5; 1 unsexed, 3.4; 12 May 1967; dredge; FSBC I 8985. — 1♀, 5.9; 21 May 1967; dredge; FSBC I 7476. — 1♂, 14.1; 3♀, 5.8-18.6; 3 June 1967; trawl; FSBC I 15613. — 4♂, 10.1-13.6; 1♂, damaged; 8♀, 7.1-21.0; 1♀, damaged; 2 July 1967; trawl; FSBC I 7478. — 1♀, 5.5; 12 July 1967; dredge; FSBC I 6657. — 1♂, 8.8; 2 August 1967; trawl; FSBC I 6654. — 1♀, 8.9; 2 August 1967; dredge; FSBC I 6653. — 6♂, 12.5-16.9; 5♀, 10.5-17.1; 1 September 1967; trawl; FSBC I 7556. — 1 damaged, 5.2; 1 September 1967; dredge; FSBC I 8987. — 2♂, 8.2, 23.6; 1♀, 14.5; 6 October 1967; trawl; FSBC I 7496. — 3♂, 10.6-18.0; 6♀, 10.5-28.5; 3 November 1967; trawl; FSBC I 15616. — HOURGLASS STATION E: 1♀, 18.6; 4 December 1965; trawl; FSBC I 1378. — 2♂, 21.1, 21.8; 4 January 1966; trawl; FSBC I 1598. — 1♂, 30.9; 3♀, 15.9-27.1; 8 February 1966; trawl; FSBC I 1959. — 1♂, 19.2; 1♀, 27.5; 8 February 1966; dredge; FSBC I 1963. — 5♂, 14.0-21.5; 2♀, 13.0, 22.1; 4 March 1966; trawl; discard. — 5♂, 8.7-18.5; 2♀, 9.3, 11.5; 7 April 1966; trawl; FSBC I 15617. — 1♀, 18.8; 7 April 1966; dredge; FSBC I 7507. — 5♂, 18.4-29.3; 6♀, 15.5-24.1; 2 damaged; 7 June 1966; trawl; FSBC I 7608. — 4♂, 11.2-22.0; 5♀, 13.9-18.0; 3 July 1966; trawl; FSBC I 7505. — 6♂, 14.4-22.8; 4♀, 15.2-25.4; 2 August 1966; trawl; FSBC I 7609. — 1♂, 12.0; 1♀, 13.3; 2 August 1966; dredge; FSBC I 15629. — 5♂, 12.7-23.4; 2♀, 18.6, 20.1; 1 September 1966; trawl; FSBC I 7554. — 1♀, 95(TL); 1 September 1966; dredge; FSBC I 15621. — 9♂, 18.8-25.6; 6♀, 19.0-32.8; 9 October 1966; trawl; FSBC I 7492. — 1♂, 17.5; 9 October 1966; dredge; FSBC I 15623. — 4♂, 19.9-23.0; 7♀, 22.2-26.7; 9 November 1966; trawl; FSBC I 15624. — 6♂, 20.0-26.2; 5♀, 22.2-30.0; 2 December 1966; trawl; FSBC I 7612. — 1♀, 28.3; 7 January 1967; trawl; FSBC I 15607. — 3♂, 12.2-19.1; 8♀, 19.1-33.1; 26 January 1967; trawl;

FSBC I 15609. — 1♂, 29.9; 5♀, 14.1-30.1; 6 February 1967; trawl; FSBC I 7517. — 1♂, 23.6; 3 March 1967; trawl; FSBC I 15625. — 1 damaged; 3 March 1967; trawl; stomach content; FSBC I 17296. — 1♂, 24.0; 8♀, 20.7-35.8; 4 April 1967; trawl; FSBC I 7475. — 1♀, 9.3; 12 May 1967; trawl; FSBC I 7477. — 1♂, 18.3; 1♀, 25.8; 2 July 1967; trawl; FSBC I 15614. — 3♂, 15.0-25.6; 5♀, 18.1-34.2; 2 August 1967; trawl; FSBC I 7607. — 1♀, 13.3; 2 August 1967; dredge; FSBC I 7543. — 5♂, 13.1-21.4; 2♀, 11.9, 13.4; 1 September 1967; trawl; FSBC I 7558. — 1♂, 17.9; 6 October 1967; trawl; FSBC I 15615. — 2♂, 11.9, 16.1; 6♀, 14.9-22.5; 3 November 1967; trawl; FSBC I 7494. — HOURGLASS STATION I: 1♀, 16.5; 30 January 1967; trawl; FSBC I 7513. — HOURGLASS STATION J: 2♂, 7.0, 7.5; 2♀, 8.4, 10.2; 12 June 1966; trawl; FSBC I 7056. — 3♂, 11.5-13.5; 6♀, 12.2-32.0; 12 October 1966; dredge; FSBC I 7550. — 2 unsexed, 3.5, 3.6; 6 December 1966; trawl; stomach content; FSBC I 7055. — HOURGLASS STATION K: 7♂, 9.6-17.2; 4♀, 13.9-27.2; 6 August 1965; trawl; FSBC I 782. — 1♂, damaged; 2♀, 13.2, 26.4; 1 damaged; 13 October 1965; trawl; FSBC I 940. — 2♂, 10.1, 25.6; 2♀, 9.5, 11.0; 12 November 1965; trawl; FSBC I 1177. — 2♀, 18.6, 21.0; 7 December 1965; trawl; FSBC I 1439. — 1♂, 10.1; 13 January 1966; dredge; FSBC I 2003. — 6♂, 11.5-20.3; 7♀, 11.5-19.6; 1 damaged; 21 March 1966; trawl; FSBC I 7616. — 1♂, 13.9; 21 March 1966; dredge; FSBC I 7552. — 2♂, 11.6, 13.6; 7♀, 11.2-20.2; 11 April 1966; trawl; FSBC I 7474. — 1♀, 14.0; 12 June 1966; trawl; FSBC I 7483. — 9♂, 14.4-23.4; 2♂, damaged; 6♀, 18.6-25.4; 2♀, damaged; 1 damaged; 5 July 1966; trawl; FSBC I 7618. — 9♂, 11.6-24.8; 2♂, damaged; 13♀, 10.6-26.7; 3♀, damaged; 13 damaged; 22 July 1966; trawl; FSBC I 3434. — 1♂, 12.1; 1♀, 9.6; 5 August 1966; trawl; FSBC I 7544. — 3♂, 11.6-16.0; 5♀, 10.2-15.4; 1 damaged; 4 September 1966; trawl; FSBC I 7530. — 3♂, 45-50(TL); 6♀, 46-110(TL); 12 October 1966; trawl; discard. — 1♂, 104(TL); 12 October 1966; dredge; discard. — 1♂, 14.6; 12 November 1966; trawl; FSBC I 6655. — 1♀, 14.8; 12 November 1966; dredge; FSBC I 7467. — 1♂, 12.6; 1♀, 13.1; 6 December 1966; trawl; FSBC I 7532. — 2♂, 16.1, 18.9; 4♀, 19.2-31.6; 1 damaged; 30 January 1967; trawl; FSBC I 7491. — 1♀, 16.7; 15 February 1967; trawl; FSBC I 7559. — 2♂, 20.6, 22.7; 1♀, 20.2; 15 May 1967; trawl; FSBC I 7486. — 2♀, 9.1, 11.9; 6 June 1967; trawl; FSBC I 7529. — 1♂, 23.6; 1♀, damaged; 5 July 1967; trawl; FSBC I 7514. — 12♂, 13.4-24.2; 9♀, 13.4-25.2; 7 August 1967; trawl; FSBC I 7614. — 2♂, 18.6, 19.3; 4♀, 16.5-21.2; 4 September 1967; trawl; FSBC I 7488. — 1 unsexed, 1.7; 4 September 1967; dredge; FSBC I 8661. — 41♂, 13.8-27.5; 30♀, 20.0-31.5; 11 October 1967; trawl; FSBC I 7620. — 2♀, 20.4, 26.9; 11 October 1967; dredge; FSBC I 7468. — 11♂, 17.0-27.3; 21♀, 15.1-29.7; 1♀, damaged; 1 damaged; 14 November 1967; trawl; FSBC I 7619. — 4♂, 22.0-26.0; 5♀, 23.8-29.7; 14 November 1967; dredge; FSBC I 7613. — HOURGLASS STATION L: 1♂, 12.6; 1♀, 13.6; 13 November 1965; trawl; FSBC I 1185. — 1♀, 11.4; 13 December 1965; trawl; FSBC I 1458. — 1♂, 14.3; 14 January 1966; trawl; FSBC I 2004. — 1♀, 19.3; 12 May 1966; trawl; FSBC I 7509. — 2♂, 15.7, 25.8; 2♀, 19.0, 28.4; 13 June 1966; trawl; FSBC I 7485. — 1♂, 15.3; 2♀, 11.3, 14.8; 6 July 1966; trawl; FSBC I 7555. — 7♀, 13.0-22.9; 1♀, damaged; 22 July 1966; trawl; discard. — 2♂, 12.3, 13.6; 1♀, 15.2; 6 August 1966; trawl; FSBC I 7533. — 5♂, 7.9-18.7; 3♀, 10.0-13.4; 1 damaged; 5 September 1966; trawl; FSBC I 7531. — 1♀, 12.0; 13 October 1966; trawl; FSBC I 7542. — 1♂, 20.1; 13 November 1966; trawl; FSBC I 7508. — 1♀, 5.6; 13 November 1966; dredge; FSBC I 6636. — 1♀, 27.9; 7 December 1966; trawl; FSBC I 7482. — 1♂, 24.0; 1♀, 29.7; 13 January 1967; trawl; FSBC I 7518. — 2♂, 19.1, 19.4; 1♀, 22.7; 31 January 1967; trawl; FSBC I 7497. — 1♂, 16.6; 1♀, 31.6; 9 March 1967; trawl; FSBC I 7498. — 1♂, 4.7; 16 May 1967; trawl; FSBC I 6638. — 1♀, 8.6; 7 June 1967; dredge; FSBC I 6651. — 1♀, 13.4; 6 July 1967; dredge; FSBC I 6648. — 2♂, 8.9, 18.1; 1♀, 9.0; 8 August 1967; trawl; FSBC I 7503. — 1♂, 16.7; 2♀, 11.7, 28.7; 5 September 1967; trawl; FSBC I 7489. — 1♀, 34.0; 12 October 1967; trawl; FSBC I 7469. — 1♀, 31.6; 15 November 1967; trawl; FSBC I 7473. — HOURGLASS STATION M: 1♀, 26.0; 14 November 1965; trawl; FSBC I 1461. — 3♂, 8.5-28.5; 1♀, 25.6; 14 January 1966; trawl; FSBC I 1674. — 1♀, 29.0; 14 January 1966; dredge; FSBC I 1678. — 1♂, 9.2; 15 February 1966; trawl; FSBC I 2066. — 2♂, 15.0, 25.6; 22 March 1966; trawl; FSBC I 7523. — 2♀, 16.0, 37.0; 13 June 1966; trawl; discard. — 1♂, 5.9; 13 June 1966; dredge; FSBC I 15626. — 5♂, 13.1-23.7; 6 July 1966; trawl; FSBC I 7465. — 1♂, 21.7; 6 July 1966; dredge; FSBC I 7515. — 7♂, 11.2-18.7; 1♀, 16.2; 6 August 1966; trawl; FSBC I 7466. — 1♂, 13.9; 5 September 1966; trawl; FSBC I 7539. — 1♂, 23.1; 5 September 1966; dredge; FSBC I 4502. — 1 unsexed, 2.7; 13 October 1966; dredge;

FSBC I 16626. — 2♂, 18.4, 25.3; 1♂, damaged; 1♀, 24.6; 13 November 1966; trawl; FSBC I 7484. — 1♀, 11.2; 7 December 1966; trawl; stomach content; FSBC I 7052. — 2♂, 15.2, 23.1; 31 January 1967; trawl; FSBC I 7500. — 1♂, 58(TL); 31 January 1967; trawl; discard. — 1♂, 26.1; 16 February 1967; trawl; FSBC I 7510. — 1 unsexed, 3.5; 9 March 1967; dredge; stomach content; FSBC I 8984. — 1♂, 12.7; 2♀, 14.0, 14.9; 7 June 1967; trawl; FSBC I 7054. — 1♂, 16.5; 1♀, 31.9; 6 July 1967; trawl; FSBC I 7535. — 1♂, 9.3; 6 July 1967; dredge; FSBC I 15628. — 1♂, 8.4; 8 August 1967; trawl; FSBC I 8986. — 1♂, 10.4; 5 September 1967; trawl; FSBC I 15627. — 1♀, 32.1; 12 October 1967; trawl; FSBC I 7501. — 1♂, 17.3; 2♀, 11.5, 24.1; 15 November 1967; trawl; FSBC I 7525.

Diagnosis: Rostrum with two dorsal teeth and bifid or trifid tip; three or four teeth on postrostral carina, posterior three teeth behind level of hepatic spine. Antennal angle armed with moderate, buttressed spine. Ischium of first pereopod unarmed.

Description: Cobb et al., 1973, pp. 7-11.

Geographic and bathymetric range: Norfolk, Virginia through Florida Keys and Dry Tortugas, around the Gulf of Mexico to Cabo Catoche, Yucatán; Bahamas; Cuba. One specimen from the Pacific coast of Mexico (Burkenroad, 1934b). Exploitable populations off Cape Lookout, North Carolina; Jacksonville and Cape Canaveral, east Florida coast; Cape San Blas, west Florida coast; Louisiana; north Texas coast; Cabo Catoche, Yucatán. Shallow water to 329 m, typically between 10 and 73 m. Exploitable populations between 34 and 55 m.

Remarks: *Sicyonia brevirostris* was the most numerous Hourglass penaeoid; 1125 specimens (1.7-37.0 mm CL) were captured in dredges and trawls (Table 12). Eight additional specimens (4.0-14.7 mm CL) were recovered from fish stomachs. This species was most abundant at 37 m stations (Figure 31). Stations D and E (55 and 73 m) contributed 56% of the northern transect catch, but Stations L and M contributed only 26% on the southern transect, probably reflecting a habitat characteristic lacking at Stations L and M.

Ranges of salinity and temperature where Hourglass specimens occurred were 31.22-36.71 ‰ and 13.9-30.0°C. On Florida's east coast, Kennedy et al. (1977) reported ranges of 32.00-36.75 ‰ and 13.8-27.6°C; Camp et al. (1977) reported 35.2-36.3 ‰ and 24.5-27.1°C. Rouse (1969) recorded 24°C and the lowest salinity, 24 ‰, in southwest Florida. Franks et al. (1972) found rock shrimp at 27.8-34.6 ‰ and 17.1-27.3°C off Mississippi.

TABLE 12. *Sicyonia brevirostris*: MONTHLY OCCURRENCES AT HOURGLASS STATIONS. TRAWL CAPTURES (TOP NO.), DREDGE CAPTURES (BOTTOM NO.).

Sicyonia brevirostris

STA	1965					1966													1967										TOT
	A	S	O	N	D	J	F	M	A	M	J	J	J sp	A	S	O	N	D	J	J sp	F	M	A	M	J	J	A	S	O	N	
A																															
				1	1		7	1				2	1																	13
B_1																															
B_2	1																				1										2
C_1		15	1	6		5	1	16		2	1	11	70	4	53	4	32	5	20	22	1	4	3		1	1	1		2	14	294
		1	1						2		2			2	2	1									1	3		1		5
C_2	1											9													4	2				13
D_1	1	1	3	2	6	3		5	5	1	5	3	50	1	8	10	8	2	5	3	1	1	1	3	4	14	1	11	3	9	17
							2			1					2	3	1		1					2			1	1			170
D_2	3		2					1			1	10		3			4							1		1					14
	1											1		1																	24
E					1	2	4	7	7		13	9		10	7	15	11	11	1	11	6	1	9	1		2	8	7	1	8	5
							2		1					2	1	1											1				152
I																				1											8
																															1
J											4					9															4
																9															9
K	11		4	4	2			14	9		1	20	40	2	9	9	1	2		7	1			3	2	2	21	6	71	34	275
						1		1								1	1										1	2	9	16
L				2	1	1				1	4	3	8	3	9	1	1	1	2	3		2		1			3	3	1	1	51
																	1				1				1	1					3
M					1	4	1	2			2	5		8	1	1	4			3					3	2	1	1	1	3	43
						1					1	1			1											1					6
TOT	15	16	10	15	12	15	13	46	23	4	33	63	169	33	89	40	61	21	28	50	10	8	13	8	10	21	38	28	79	69	1040
	3	1	1			2	4	1	1	1	1	11	9	3	5	15	4		1		1			3	5	4	4	2	4	9	85

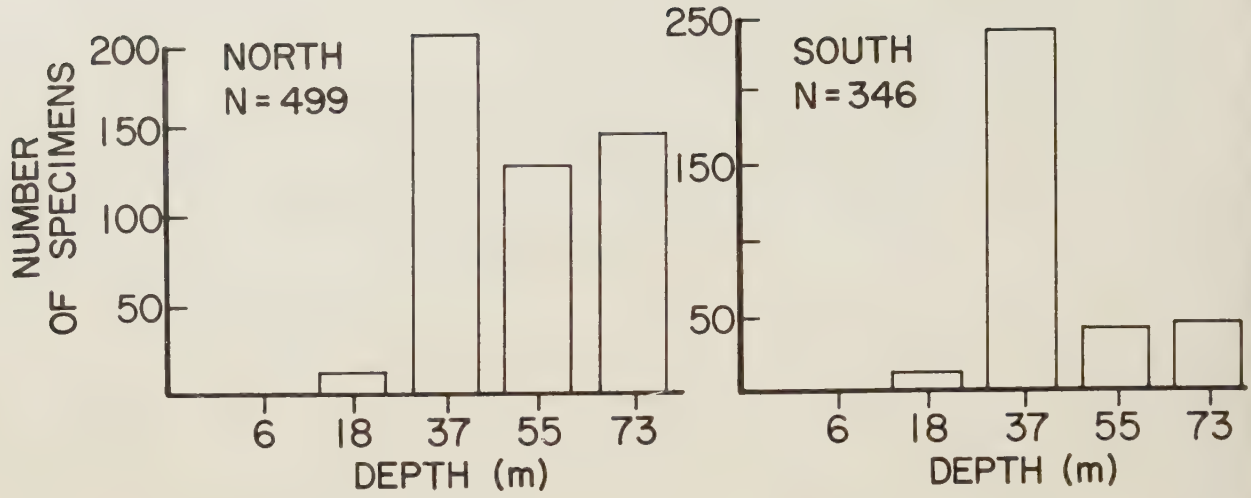


Figure 31. *Sicyonia brevirostris*: Abundance at stations on north and south transects during regular sampling.

Rock shrimp are most abundant on sand bottoms (Hildebrand, 1954, 1955; Menzel, 1956; Williams, 1965; Camp et al., 1977). Kennedy et al. (1977) described a sediment composition of fine to medium grained quartzose and shell sands supplemented by mollusk, foraminiferal, and barnacle fragments. These commercial grounds of Florida's northeast coast also included gravelly shell sand and scleractinian coral fractions. *Sicyonia brevirostris* from Hourglass sampling came from similar substrates (Cobb et al., 1973).

Peak abundances during regular Hourglass sampling generally occurred in late summer and fall (Figure 32); supplementary trawls yielded more shrimp in July (162) than in December (50). A similar seasonal abundance pattern was also observed by Kennedy et al. (1977) off northeast Florida and Lunz (1957) off South Carolina. High occurrences were observed from June through January off Louisiana and northeast Texas (Brusher et al., 1972). Commercial production in 1975 (U. S. Department of Commerce) was highest during these months. Florida's east coast had high production in November, December and January; west coast (Apalachicola at Cape San Blas) production was highest in late summer, remaining high during all of fall and winter. However, landings at Apalachicola maintained relatively high levels year-round, reflecting a greater economic demand for all sizes and less demand for seasonally available large shrimp. Texas production peaked in March and December but never reached levels maintained in Florida.

Diel sampling captured many more rock shrimp at night (350) than in daylight (61). Stomachs of specimens from daylight sampling were empty, indicating nocturnal activity (Cobb et al., 1973). Additionally, diurnal dredging was relatively successful, accounting for 40% of total day captures, as compared to only 5% dredged night captures, indicating daylight burrowing and consequent inactivity as noted by Cobb et al. (1973). Anderson (1956), Lunz (1957), Joyce (1965), Brusher et al. (1972), Brusher and Ogren (1976), Camp et al. (1977) and Kennedy et al. (1977) have also reported preponderent nocturnal abundance.

As previously mentioned, most Hourglass catches were from trawls (93% of regular sampling). Supplementary trawling yielded 22% of rock shrimp caught in all night trawls, constituting the highest penaeoid catch proportion for this gear.

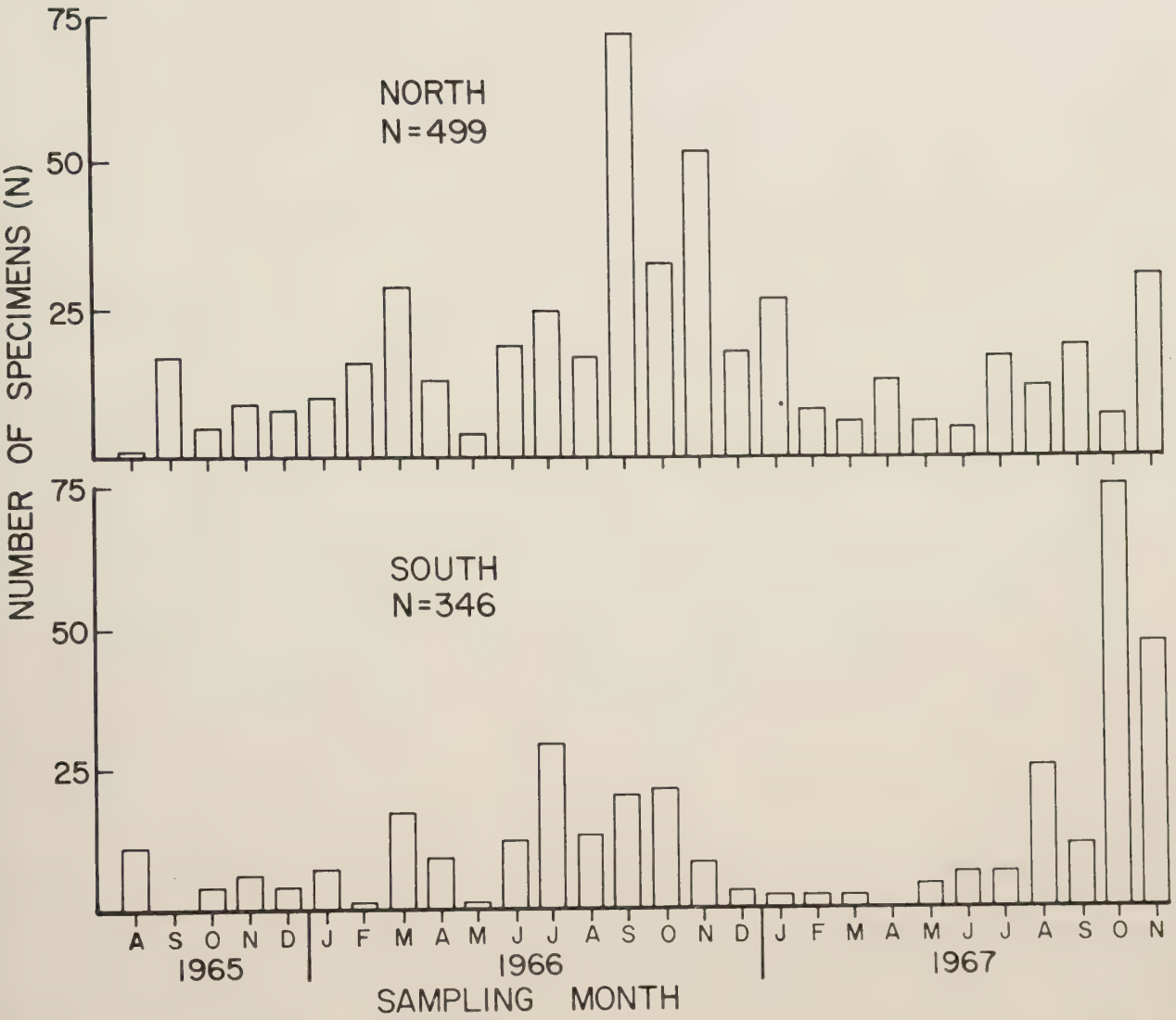


Figure 32. *Sicyonia brevirostris*: Intertransect monthly abundance during regular sampling.

Size frequency analysis, developed for specimens captured during regular sampling, revealed an obvious increase in modal lengths beginning in June and continuing through December (Figure 33). The largest modal length (30 mm class) occurred in February. Smallest modal length (4 mm class), occurred in May, indicating recruitment began soon before May. Off season recruitment, also evident in northeast coast populations (Kennedy et al., 1977), occurred in October, December and March. Structural and temporal characteristics of Hourglass populations were remarkably similar to those reported for Florida's northeast coast (Kennedy et al., 1977).

Kennedy et al. (1977) estimated juvenile growth for two generations during summers of two years. Juvenile growth was 2.3 to 3.3 mm CL per month. Adult monthly growth, also estimated for two generations, ranged between 0.5 and 0.6 mm CL.

Carapace length/total length relationships (Figure 34) were assessed for 174 males and 219 females. Male CL/TL conversion was TL = 0.5473 + 3.7687 CL; since a t-test revealed no significant difference

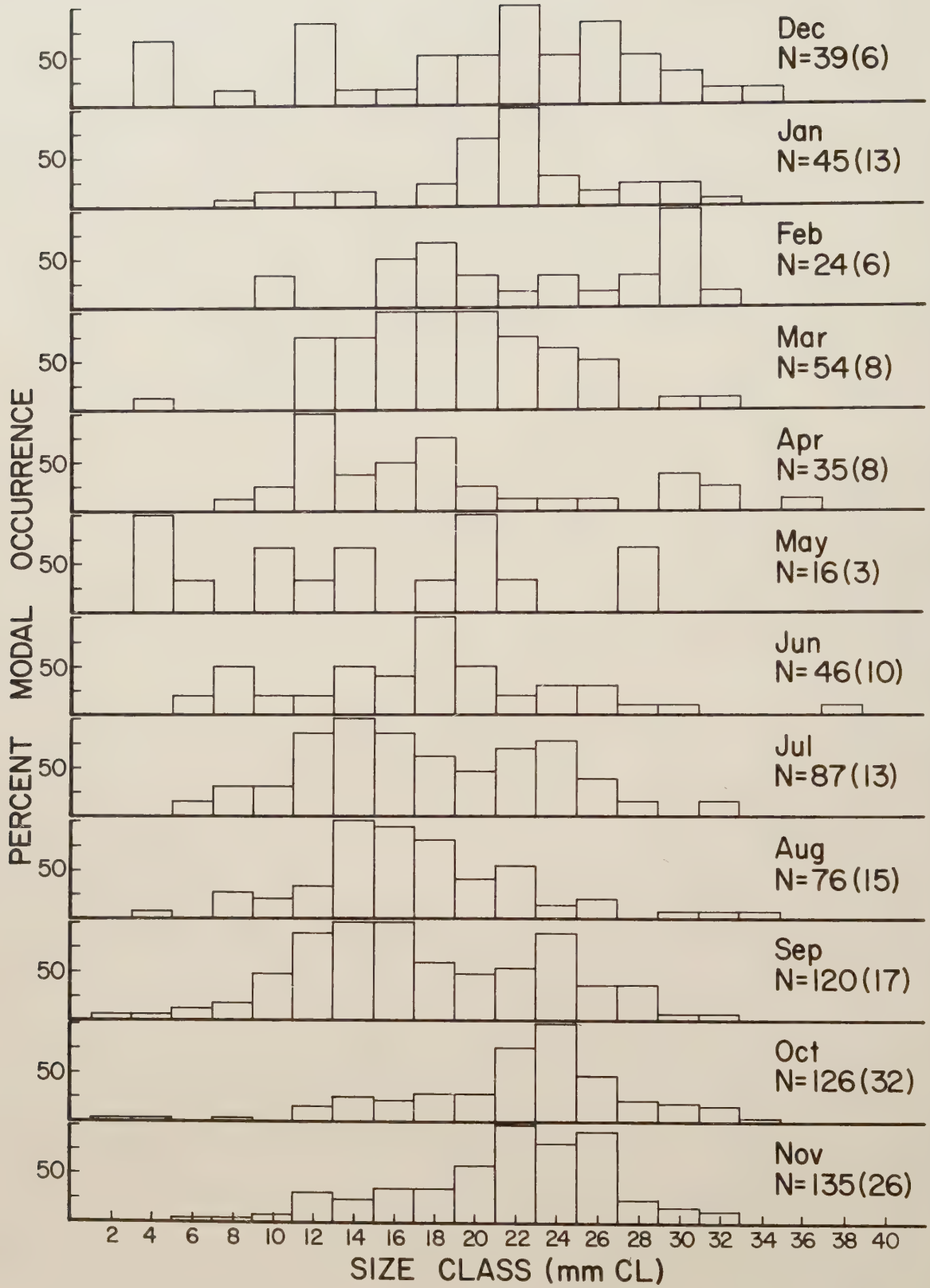


Figure 33. *Sicyonia brevirostris*: Combined monthly length frequencies for last 24 sampling months. 2 mm CL size classes, total N (modal N).

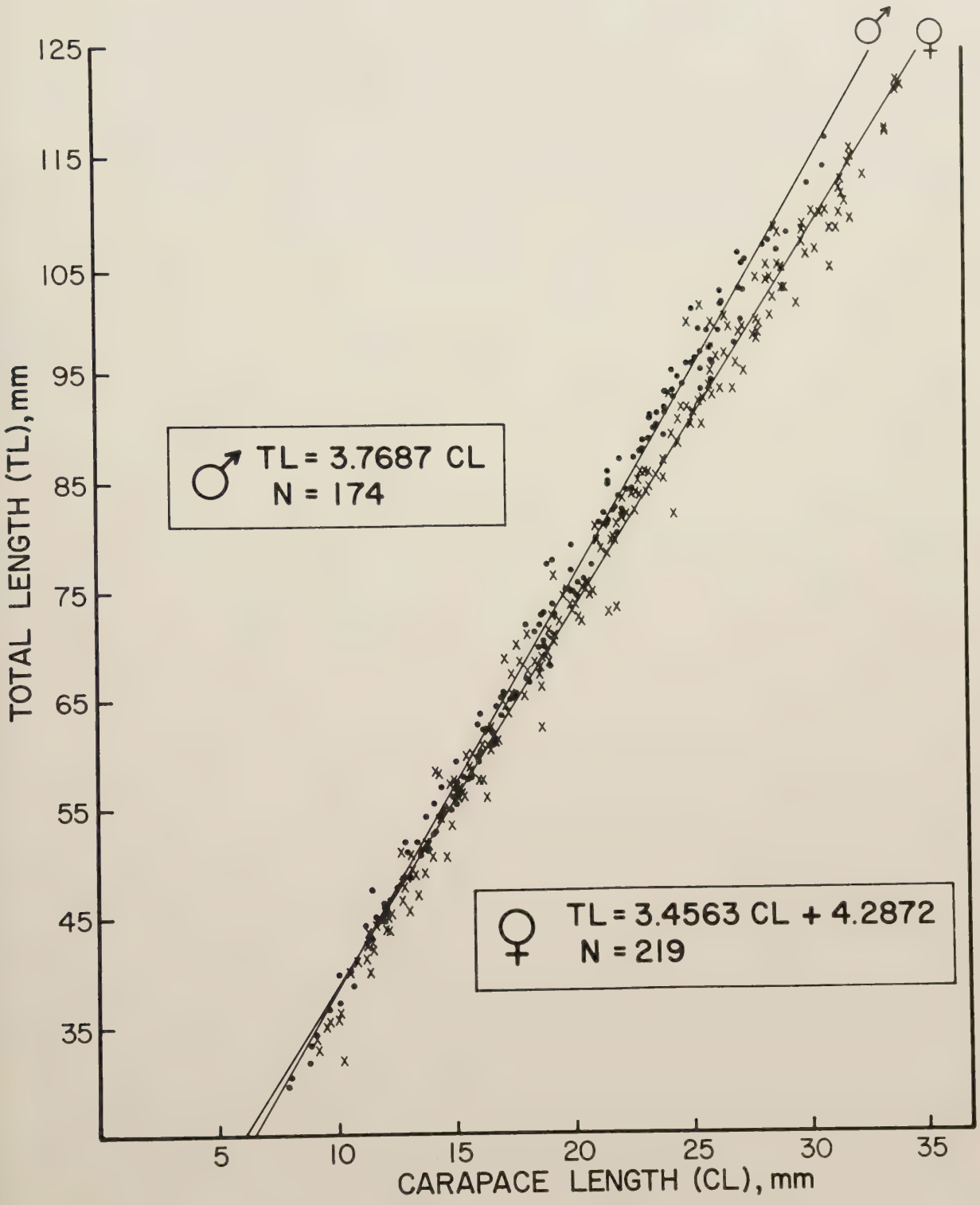


Figure 34. *Sicyonia brevirostris*: Male and female CL-TL relationships; • = ♂, x = ♀.

between the y-intercept (0.5473) and the origin, this regression equation was simplified to TL = 3.7687 CL. Female lengths were related by the equation TL = 3.5463 CL + 4.2872.

Carapace length/weight relationships assessed for each sex (Figure 35) were significantly different (ANCOVA) from one another (P = 0.05). Variates were grouped in 1 mm size classes, and ten pairs were randomly selected from each class. All pairs were utilized if there were ten or less variates in a size group. Male CL/WT relationship was $WT = 5.0598 \times 10^{-4} CL^{3.2094}$; females were related by $WT = 4.8428 \times 10^{-4} CL^{3.1907}$.

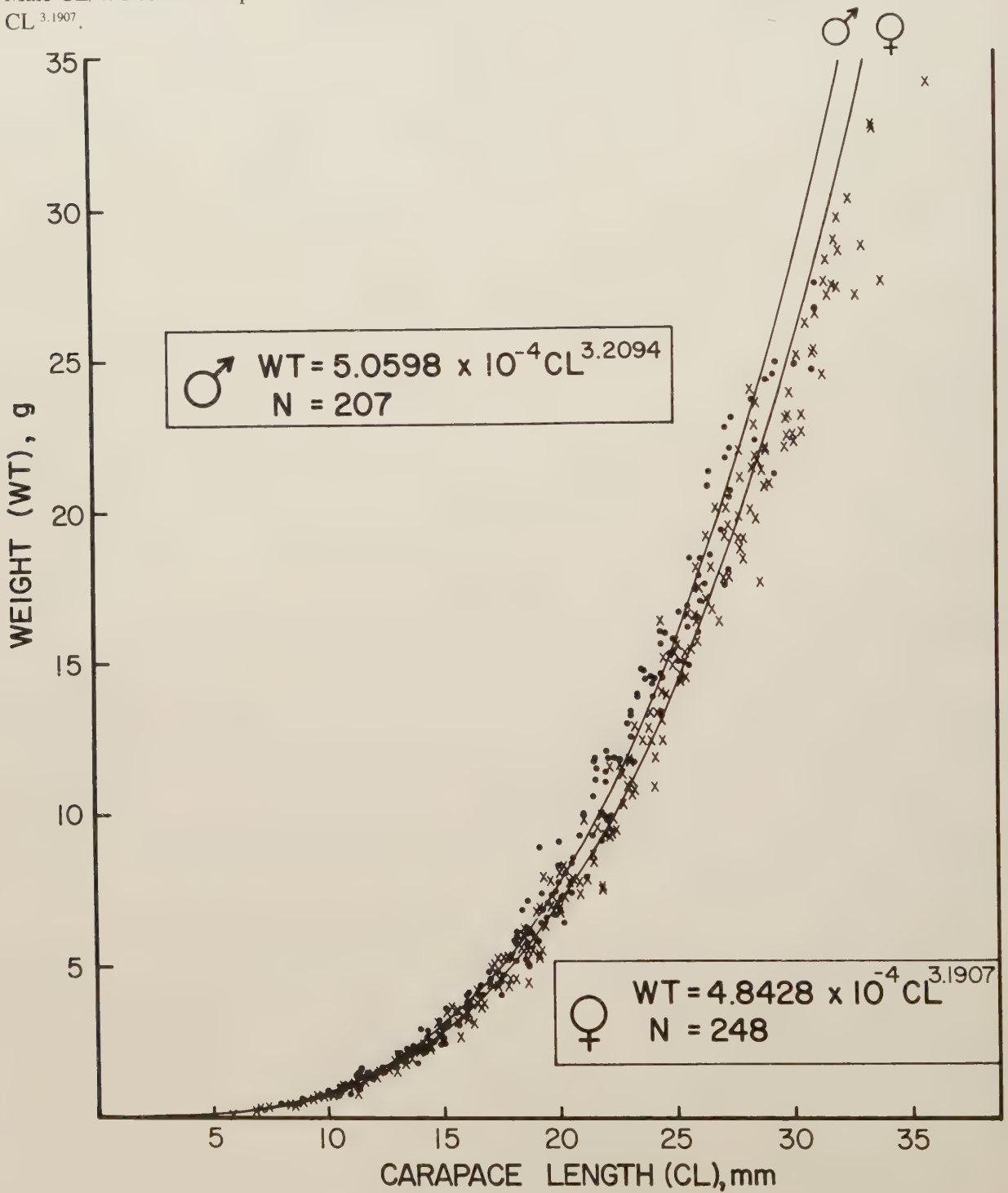


Figure 35. *Sicyonia brevirostris*: Male and female CL-WT relationships; • = ♂, x = ♀.

TABLE 13. *Sicyonia brevirostris*: CARAPACE LENGTH-WEIGHT REGRESSION FORMULAE FOR WEST AND EAST COAST POPULATIONS.

Sex and Size	West Coast (Hourglass) Formula	r	East Coast Formula	r
♂ < 23	$W=4.252x10^{-4}CL^{3.226}$	0.99	$W=4.104x10^{-4}CL^{3.303}$	0.99
♀ < 23	$W=5.9728x10^{-4}CL^{3.126}$	0.99	$W=3.398x10^{-4}CL^{3.364}$	0.99
♂ ≥ 23	W = 1.865 CL - 32.065	0.95	W = 1.886 CL - 30.922	0.96
♀ ≥ 23	W = 1.762 CL - 27.971	0.97	W = 1.818 CL - 30.475	0.98

Kennedy et al. (1977) recognized a change of growth for sizes ≥23 mm CL, where CL/WT relationships changed from exponential to linear. This change was also evident in Hourglass populations; these values may be found in Table 13. Unfortunately, weights used to develop northeast coast CL/WT regression lines were coded by multiplying each individual weight by 100 (Kennedy, personal communication), eliminating analysis of covariance between the two populations without extensive recalculations of either set of data.

Analysis of covariance between sexes in each Hourglass size group revealed significant differences similar to those found in northeast coast populations. Males smaller than 23 mm CL grew at a slightly faster rate than did similar sized females, maintaining larger sizes than females of similar age for lengths greater than 23 mm CL. However, growth rates became similar for both sexes as they attained lengths greater than 23 mm CL. Appendix I contains necessary information to construct these formulae and conduct ANCOVA with other similar analyses.

Kennedy et al. (1977) estimated the life span of *S. brevirostris* by repetitive monitoring of a single year class. Their estimate, including larval growth (1 month) and postlarval development (2-3 months), was 20 to 22 months.

Sex ratios of rock shrimp vary according to size (Lunz, 1957; Joyce, 1965; Cobb et al., 1973; Kennedy et al., 1977), but apparently do not deviate from unity in the entire population. Comparisons between studies were difficult to make, but all concluded that females outnumbered males in larger size classes. Lunz (1957) reported more females in sizes above approximately 35 mm CL, and twice as many males as females at 13-30 mm CL. Joyce (1965) reported more females in lengths greater than 17 mm CL. Cobb et al. (1973) showed that Hourglass females became significantly more numerous in lengths above 25 mm CL. Kennedy et al. (1977) evaluated sex ratios for each 1 mm CL size class and found that females began to outnumber males at

TABLE 14. *Sicyonia brevirostris*: SIZE CLASS-SEX RATIO COMPARISON BETWEEN WEST AND EAST COAST POPULATIONS.

Size	West Coast (Hourglass) Ratio	P(.05) Chi-square	East Coast Ratio
> 23	♂♂< ♀♀	32.82*	♂♂< ♀♀
15 ≤ 23	♂♂ > ♀♀	6.66*	♂♂ > ♀♀
11 ≤ 14	♂♂ = ♀♀	0.07 NS	♂♂ = ♀♀
< 11	♂♂ = ♀♀	1.50 NS	♂♂< ♀♀

* = significant.
NS = not significant.

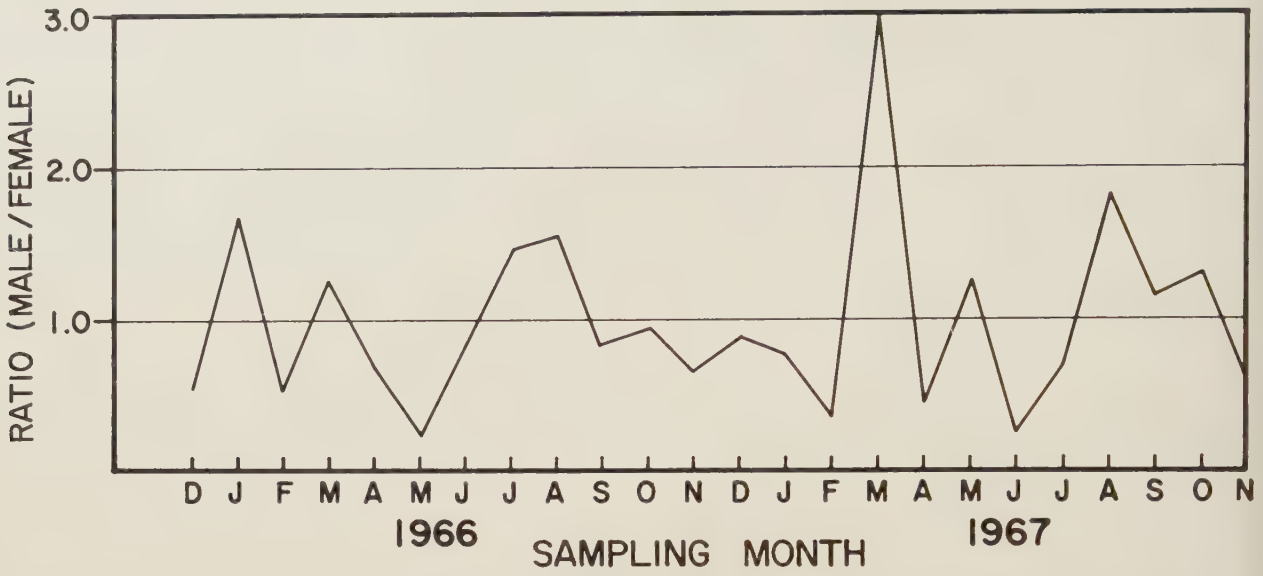


Figure 36. *Sicyonia brevirostris*: Monthly male/female ratio during last 24 months of regular sampling.

lengths greater than 23 mm CL. Results of this analysis on rock shrimp from Florida's east coast and results in similar analyses of Hourglass specimens are presented in Table 14. Hourglass analyses included Chi-square tests of ratios (Sokal and Rohlf, 1969) and showed where significant deviations from unity occurred. Kennedy et al. (1977) concluded that misidentification of small males as females contributed to the unequal sex ratio in lengths less than 11 mm CL. Increased mortality of males greater than 23 mm CL accounted for more numerous females in this size group. Reasons for a ratio favoring males between 15 and 23 mm CL remained unclear, but such ratios were characteristic of both Florida northeast and west coast populations. Monthly evaluation of sex ratio (regular sampling) revealed no seasonal or annual trends (Figure 36).

Reproductive size characteristics of this population were assessed by Cobb et al. (1973). Developmental stages of ovaries (Table 15, reproduced from Cobb et al., 1973) were used to determine female sexual maturity. Male maturity estimates were based on presence or absence of joined petasmata. Most mature females (developed stage) occurred at lengths greater than 19.0 mm CL. The smallest mature female was 12.0 mm CL, but occurrences were uncommon for developed or ripe females less than 19.0 mm CL. On Florida's northeast coast the smallest mature female was 17.0 mm CL; the smallest specimen with a ripe ovary was in the 19 mm size class (Kennedy et al., 1977). Onset of maturity occurred in Hourglass males at 9.0 mm CL, and all were mature by 11.0 mm CL. Northeast coast males first displayed petasmal coupling in 10 mm CL size classes, and all males were mature by 14.0 mm CL (Kennedy et al., 1977). Hence, sexual maturity was apparently reached much sooner for females and slightly earlier for males in west coast populations than in northeast coast populations.

Analysis of monthly ovarian development (Table 16, reproduced from Cobb et al., 1973) showed that October through February were peak spawning months. Some year-round spawning was also evident; ripe or spent females were found in all months except May and June.

Off Florida's northeast coast, spawning seasons during two years (1972, 1973) began in December. Spawning was most intense from January through March. Another year's spawning season began in October (1974) with some year-round spawning evident in all three years. Bryan and Cody (1975a) concluded that spawning in Texas waters was prevalent from November through March.

TABLE 15. *Sicyonia brevirostris*: OVARIAN DEVELOPMENT FOR 2 MM CL SIZE GROUPS.*

Size class (CL, mm)	Ovarian Developmental Stages										Total
	Undeveloped (U)		Early Developing (ED)		Developed (D)		Ripe (R)		Spent (S)		
	N	%	N	%	N	%	N	%	N	%	
3.0-4.9	1	100	—	—	—	—	—	—	—	—	1
5.0-6.9	3	100	—	—	—	—	—	—	—	—	3
7.0-8.9	9	100	—	—	—	—	—	—	—	—	9
9.0-10.9	16	94	1	6	—	—	—	—	—	—	17
11.0-12.9	31	86	3	8	1	3	1	3	—	—	36
13.0-14.9	34	77	7	16	2	5	1	2	—	—	44
15.0-16.9	27	66	11	27	2	5	1	2	—	—	41
17.0-18.9	7	19	25	68	3	8	1	3	1	3	37
19.0-20.9	8	23	19	54	5	14	3	9	—	—	35
21.0-22.9	4	9	21	46	16	35	5	11	—	—	46
23.0-24.9	5	10	18	36	18	36	8	16	1	2	50
25.0-26.9	2	3	23	37	27	44	8	13	2	3	62
27.0-28.9	1	3	7	23	18	60	3	10	1	3	30
29.0-30.9	—	—	4	16	13	52	6	24	2	8	25
31.0-32.9	—	—	8	40	7	35	4	20	1	5	20
33.0-34.9	—	—	1	20	2	40	1	20	1	20	5
35.0-36.9	—	—	—	—	—	—	—	—	1	100	1
37.0-38.9	—	—	—	—	1	100	—	—	—	—	1
Total	148		148		115		42		10		463

*Reproduced from Cobb et al. (1973).

TABLE 16. *Sicyonia brevirostris*: MONTHLY OVARIAN DEVELOPMENT.*

Month	Ovarian Developmental Stages										Total
	Undeveloped (U)		Early Developing (ED)		Developed (D)		Ripe (R)		Spent (S)		
	N	%	N	%	N	%	N	%	N	%	
January	6	13.6	15	34.1	16	34.6	7	15.9	1	—	44
February	1	6.6	4	26.6	9	60.0	—	—	1	6.6	15
March	5	26.3	10	52.6	3	15.8	1	5.3	—	—	19
April	5	27.8	6	33.3	3	16.7	3	16.7	1	5.6	18
May	2	50.0	2	50.0	—	—	—	—	—	—	4
June	13	54.2	8	33.3	3	12.5	—	—	—	—	24
July	42	44.7	36	38.3	13	13.8	2	2.1	1	1.1	94
August	14	51.9	9	33.3	3	11.1	1	3.7	—	—	27
September	25	49.0	15	19.4	5	9.8	5	9.8	1	1.9	51
October	11	17.5	19	30.2	24	38.1	8	12.7	1	1.6	63
November	20	23.5	21	24.7	28	32.9	13	15.3	3	3.5	85
December	4	21.1	3	15.8	8	42.1	2	10.5	2	10.5	19
Total	148		148		115		42		10		463

*Reproduced from Cobb et al. (1973)

Sicyonia brevirostris in Florida waters is not dependent upon inshore low salinity nurseries for recruitment stock. Kennedy et al. (1977), using step-oblique plankton tows, found larvae year-round between 26 and 40 m, inshore of adult populations. Eldred (1959) and Joyce (1965) similarly concluded that Tortugas and northeast Florida rock shrimp utilized offshore areas for larval and juvenile development. In the northern Gulf of Mexico this situation may be modified by juveniles concentrating closer to land and penetrating high salinity bays. Brusher and Ogren (1976) found small *S. brevirostris* at all of their stations within the St. Andrew Bay system. However, rock shrimp were most abundant at stations in the more neritic environment nearest the Gulf. Additionally, these authors characterized St. Andrew Bay as possessing environmental qualities more similar to open gulf waters than to typical estuarine conditions. They recognized that this allowed occurrences of shrimps normally associated with offshore environs, speculating that *S. brevirostris* moved offshore during spring where it is commercially exploited.

These studies indicate an important life history aspect of *S. brevirostris*. The shelf of Florida's northeast coast and central west coast gently slopes, producing abundant sand/shell habitat for juvenile and adult populations. Offshore of Florida's northwest coast (St. Andrew Bay area), shelf area is not nearly as extensive and less habitat is offered in the depth ranges supporting large juvenile and adult populations. Shelf slope off northwest Florida is 15 m or more per mile (Tanner, 1960). Evidently, juvenile rock shrimp are less depth selective than adults and if a sand/shell-high salinity habitat is available in nearshore shallow areas, they will occupy it. Food is probably more available and competition with large adult populations (concentrated between 34 and 55 m) is eliminated.

Stomach contents of 130 specimens were examined from night and day trawls. All stomachs from day sampling were empty and 80% of stomachs collected at night were at least 50% full (Table 17, modified from

TABLE 17. *Sicyonia brevirostris*: FOOD ITEM CONTENT AND COMPOSITION IN 130 STOMACHS.***

Item	Predominant		Residual		Total	
	N	%*	N	%*	N	%*
Algae	0	—	3	3	3	3
Porifera spicules	1	1	4	4	5	5
Foraminiferida	0	—	35	33	35	33
Nematoda	0	—	12	11	12	11
Polychaeta	0	—	4	4	4	4
Mollusca						
Bivalvia	77	72	15	14	92	86
Gastropoda	8	8	48	45	56	53
Pycnogonida	0	—	8	8	8	8
Stomatopoda	1	1	0	—	1	1
Crustacea						
Unidentifiable fragments	3	3	17	16	20	19
Ostracoda	0	—	11	10	11	10
Amphipoda	3	3	7	6	10	9
Isopoda	0	—	1	1	1	1
Decapoda						
Natantia	10	9	6	6	16	15
Brachyura	5	5	6	6	11	10
Anomura	5	5	4	4	9	9
Ectoprocta	1	1	6	6	7	7
Echinoidea	0	—	3	3	3	3
Pisces	0	—	3	3	3	3
Empty					23	18**

*Percent of stomachs (107) containing food.
**Percent of total stomachs (130) examined.
***Modified from Cobb et al. (1973).

Cobb et al., 1973). Hourglass rock shrimp were nocturnal, benthic, generalized carnivores, consuming food in similar proportions to those on Florida's northeast coast. Additionally, Kennedy et al. (1977) demonstrated that *S. brevirostris* consumed organisms in proportion to the organisms' abundance in the benthic fauna, concluding that rock shrimp were opportunistic feeders.

Sicyonia brevirostris was recovered from stomachs of five fish species and appeared in three species of scorpion fish. Four shrimp (4.0-6.0 mm CL) were found in stomachs of three *Scorpaena calcarata* captured at Stations C and E. One female (14.0 mm CL) was in a *S. brasiliensis* from Station D and a damaged specimen was in a *S. agassizi* from Station E. A *Diplectrum formosum* had eaten a female rock shrimp (14.0 mm CL) at Station B. A damaged male was found in a dusky flounder (*Syacium papillosum*) captured at Station D.

Sicyonia burkenroadi Cobb, 1971

Figure 37

Sicyonia dorsalis: Rathbun, 1901, p. 103 [part]; Verrill, 1922, pp. 49, 50 [not *Sicyonia dorsalis* Kingsley, 1878].

Eusicyonia stimpsoni: Burkenroad, 1934b, pp. 123-125 [part]; 1939, pp. 57, 58; ? Pearson, 1939, pp. 60-71 [mysis I and II, figs. 65, 66]; Lunz, 1945, p. 10 [part] [not *Sicyonia stimpsoni* Bouvier, 1905].

Sicyonia stimpsoni: Springer and Bullis, 1956, p. 10; Bullis and Thompson, 1965, p. 7 [part]; Williams, 1965, pp. 33, 38 [part] [not *Sicyonia stimpsoni* Bouvier, 1905].

Sicyonia burkenroadi Cobb, 1971, pp. 104-111, figs. 1, 2.

Material examined: HOURGLASS STATION E: 1♂, 6.4; 1♀, 8.4; 7 April 1966; trawl; FSBC I 2411. — 1♀, 7.5; 2 August 1966; trawl; FSBC I 3633. — 1♀, 14.3; 2 December 1966; trawl; stomach content; FSBC I 6622.

Diagnosis: Rostrum variously elevated, with three, rarely four, dorsal teeth; tip usually bifid. Postrostral carina with small tooth anterior to hepatic spine, large keel-like tooth arising from posterior margin of carapace. Antennal angle armed with slender, buttressed spine. Ischium of first pereopod unarmed. First four abdominal pleura with anteroventral margin rounded, armed with acute laterodorsally curved spine; posteroventral margin rounded. Fourth and fifth abdominal tergal carina with well developed, posteriorly directed tooth.

Description: Cobb, 1971, pp. 105-109.

Geographic and bathymetric range: Cape Lookout, North Carolina, southward and through the Gulf of Mexico to Golfo de Campeche; Puerto Rico; Panama; Colombia; Guyana; Surinam; French Guiana. Depth 33-118 m.

Remarks: Three *Sicyonia burkenroadi* (6.4-8.4 mm CL) were caught during regular sampling. An additional specimen (♀, 14.3 mm CL) was recovered from a sea robin (*Prionotus alatus* Goode and Bean) trawled at Station E in December, 1966. *Sicyonia burkenroadi* exclusively occurred in trawl samples.

Salinities and temperatures where it was found ranged from 36.19 to 36.28 ‰ and from 17.5 to 19.0°C.

Finer substrates where this species was found at Station E were consistent with those listed for this species by Cobb (1971): mud, mud-shell, or mud-sand bottom.

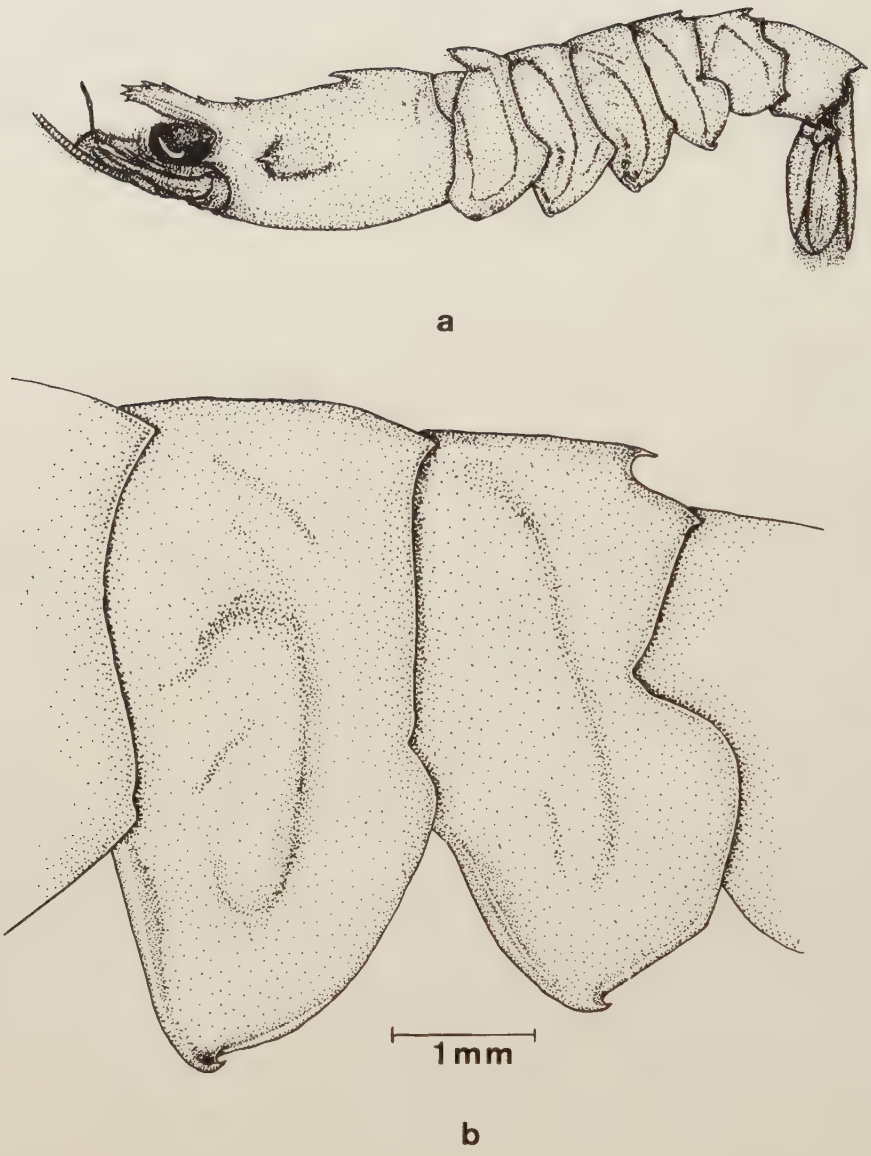


Figure 37. *Sicyonia burkenroadi*: a. ♀, 7.5 mm CL, ventral appendages omitted, FSBC I 3633; b. ♀, 7.5 mm CL, detail of 3rd and 4th abdominal segments, FSBC I 3633.

Sicyonia burkenroadi most closely resembles *S. stimpsoni* but differs by possessing a posteriorly directed tooth on the fourth tergal carina and a laterodorsally curved spine on the first four abdominal pleura; such projections are lacking on *S. stimpsoni*. Depth distributions of these two species overlap between 73 and 118 m. However, 77% of *S. burkenroadi* have occurred in less than 73 m and 88% of *S. stimpsoni* have been collected at depths greater than 118 m. *Sicyonia burkenroadi*, an inhabitant of the outer shelf and upper slope, was apparently more abundant in the northwestern Gulf of Mexico and off northeastern South America than in the eastern Gulf (Cobb, 1971).

Sicyonia laevigata Stimpson, 1871

Figure 38

Sicyonia laevigata Stimpson, 1871, pp. 131, 132; Kingsley, 1880, p. 426; Rathbun, 1901, p. 103; Hay and Shore, 1918, pp. 379, 380; Wass, 1955, pp. 132, 142; Menzel, 1956, p. 41; Eldred et al., 1965, pp. 3, 32; Joyce and Eldred, 1966, p. 24; Rouse, 1969, p. 136; Lyons et al., 1971, p. 28; Camp et al., 1977, pp. 23, 43, 46, 48.

Material examined: HOURGLASS STATION A: 2♂, 2.0, 4.0; 1♀, 4.5; 3 March 1966; trawl; FSBC I 6637. — 1♀, 47(TL); 6 April 1966; dredge; discard. — HOURGLASS STATION B: 1♂, 4.0; 2 May 1966; dredge; FSBC I 6645. — 1♀, 7.0; 11 May 1967; dredge; FSBC I 8069. — 1♀, 4.7; 1 July 1967; dredge; FSBC I 8074. — 1♂, 3.5; 1 August 1967; dredge; FSBC I 6647. — 1♀, 5.3; 11 September 1967; dredge; FSBC I 8076. — 1♀, 8.6; 2 November 1967; trawl; FSBC I 8993. — 1♂, 4.9; 5♀, 3.1-7.2; 1♀, damaged; 2 November 1967; dredge; FSBC I 6726. — 1♂, 4.0; 20 November 1967; dredge; FSBC I 8080. — HOURGLASS STATION C: 1♀, 3.9; 3 January 1966; dredge; FSBC I 8064. — 1♀, 12.8; 5 October 1967; dredge; FSBC I 6619. — HOURGLASS STATION I: 1♂, damaged; 12 November 1965; trawl; FSBC I 8988. — 1♀, 8.5; 1 damaged; 9 March 1966; trawl; FSBC I 2221. — 1♂, 2.9; 21 March 1966; dredge; FSBC I 2237. — 1♀, 2.2; 12 November 1966; dredge; FSBC I 8989. — 1 damaged; 7 April 1967; dredge; FSBC I 8990. — 1♀, 3.5; 5 July 1967; dredge; FSBC I 8991. — 2♂, 3.0, 3.5; 1♀, 4.4; 1 unsexed, 1.7; 4 September 1967; dredge; FSBC I 8992. — 1♀, 2.5; 1 damaged; 14 November 1967; dredge; FSBC I 8994.

Diagnosis: Rostrum elevated about 20°, with two dorsal teeth anterior to orbital margin; tip with two to four (usually four) small, deflexed teeth. Three teeth on postrostral carina posterior to orbital margin; anterior tooth slightly ahead of level of hepatic spine, middle tooth largest. Antennal angle unarmed, obtuse. Ischium of first pereopod armed.

Description: Rostrum varying in length, reaching from level of distal half of first segment of antennular peduncle to slightly beyond third segment of peduncle; dorsal margin with two small teeth exclusive of tip, posterior tooth always anterior to level of orbital margin; tip composed of dorsal array of from two to four teeth, becoming increasingly deflexed in series from dorsal to ventral; ventral margin with subapical tooth widely separated from dorsal array by intercalated node. Postrostral carina low, armed with small tooth anterior to level of hepatic spine, two large teeth posterior to level of hepatic spine. Antennal angle obtuse, unarmed. Hepatic spine long, slender.

Mesial antennular flagellum 0.75 length of stouter lateral flagellum. Lateral antennular flagellum 0.80 length of antennular peduncle. Antennular peduncle slightly exceeding length of scaphocerite.

Length of scaphocerite three times maximum width; spine slightly exceeding distal edge of scale, reaching to origin of antennular flagellum. Length of antennal flagellum approximately three times carapace length.

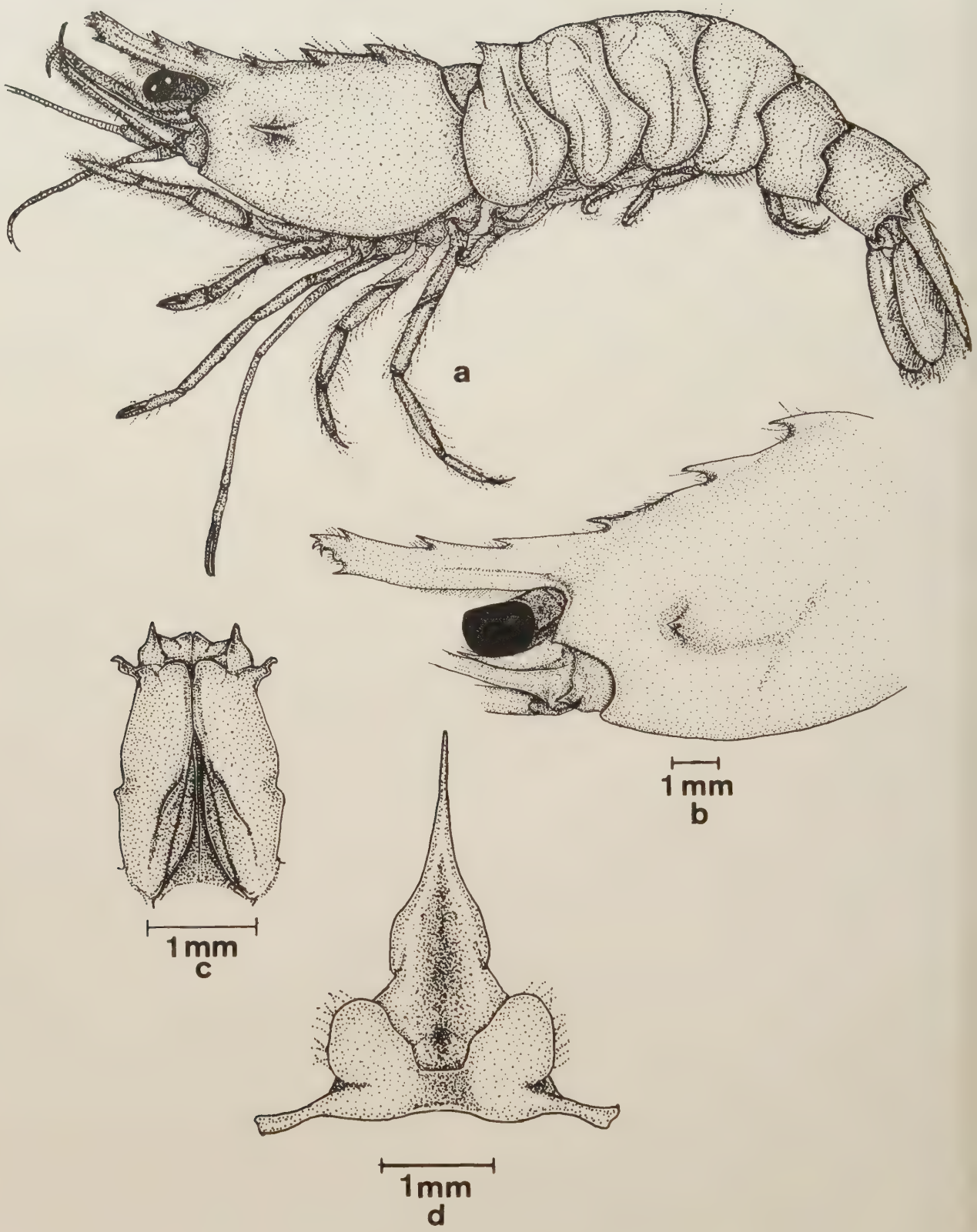


Figure 38. *Sicyonia laevigata*: a. ♀, 11.3 mm CL, FSBC I 362; b. ♀, 10.8 mm CL, detail of head, FSBC I 413; c. ♂, 5.5 mm CL, petasma, FSBC I 17572; d. ♀, 11.3 mm CL, thelycum, FSBC I 362.

Third maxilliped reaching to mid-length of scaphocerite; length of dactyl about 0.60 of prodopus. First pereopod almost reaching distal margin of carpocerite. Second pereopod reaching to approximately same level as third maxilliped. Third pereopod overreaching scaphocerite by approximately half length of dactyl. Fourth pereopod not quite reaching distal margin of basicerite. Fifth pereopod reaching to level of distal margin of eye. Small, stout spine extending from ventrodistal margin of ischium of first pereopod.

Abdominal somites with high tergal carina, produced as large, acute anteriorly directed tooth on first somite and smaller, acute, posteriorly directed tooth on sixth somite. First four somites with ventral margins rounded; last two somites furnished with acute tooth on posteroventral angle. First somite traversed by short, often obscure, anteromedian pleural sulcus and long posterior sulcus produced by confluence of posterior tergal and posteromedian pleural sulci. Second and third somites each with long anterior tergal and short posterior tergal sulci, short anteromedian pleural and longer posteromedian pleural sulci curving anteriorly near midpoint of somite. Fourth and fifth somites each with long anterior tergal sulcus and long posterior sulcus produced by confluence of posterior tergal and posteromedian pleural sulci. Sixth somite with deep longitudinal sulcus and shallow posteromedian pleural sulcus. Telson with median sulcus which shallows posteriorly and terminates before reaching tip. Telson tip flanked by short subterminal spines. Mesial ramus of uropod slightly exceeds telson tip; lateral ramus about the same length as mesial ramus with stout, distolateral spine which does not exceed posterior margin of ramus.

Median process (sternite XIII) of thelycum narrow, length about 3.0 width, distinctly tilted anteroventrally, extending anteriorly as long, lanceolate spine to level of base of second pereopods; concave mesially. Transverse plate (sternite XIV) with bosses tilted anteroventrally, aliform; lateral and anterior margins curved; mesial concavity bordered posteriorly by short transverse ridge.

Ventral lobules of petasma gaping proximally, lateral margins narrowing distally, with deep notch near midpoint; distolateral corners produced as small tooth with blunt tip irregularly curved laterally, distomedial corners rounded, slightly produced distally; distolateral corners of dorsal lobules produced as large, cornuate tooth directed dorsally.

Appendix masculina terminating in scyphiform bud with median portion of rim elevated, margin setose. Endopod of second pleopod with small lamina, distinctly overreaching appendix masculina arising along medial margin.

Color of fresh specimens: Carapace with oblique band of dark maroon on posterior branchiostegal region; cardiac region with large green spot laterally; remainder of carapace grayish-brown with small irregularly shaped white spots; rostrum dark maroon. Eye stalks with ill-defined longitidinal stripes of cream and maroon. Scaphocerite and antennular peduncle flecked with maroon. Antennal flagellum banded with maroon and cream. Abdomen dark brownish-maroon mottled with white and green; ventral margin of pleura white mottled with brown. Telson and uropods rusty brown. Pereopods and pleopods pinkish, mottled with maroon.

Morphological variation: Ontogenetic changes in the rostral tip and rostral length were the most evident morphological variations of *Sicyonia laevigata*. Rostral elevation ranged from 0° to 40°, but showed little relationship to size. Lunz (1945) stated that rostral elevation increased with age, but much variation in this character was noted in Hourglass specimens. Rostral length increased regularly with age, falling short of the distal margin of the first segment of the antennular peduncle of the smallest specimen and overreaching the third segment of the peduncle of the largest shrimp. Number of teeth in the dorsal array of the rostral tip tended to increase with size from two to four, and the ventral tooth was spaced increasingly posterior with increasing shrimp size.

Geographic and bathymetric range: Cape Hatteras, North Carolina, southward into the Gulf of Mexico to northwest Florida; north coast of Yucatán; West Indies; Colombia; Pacific coast of Panama. Protected shallow bays to 90 m.

Remarks: Thirty-three *Sicyonia laevigata* (1.7-12.8 mm CL) were caught during this program (Table 18). More abundant on the northern transect, this species occurred at Stations A through C and was most numerous at Station B (18 m). On the southern transect, it occurred only at Station I (6 m). Like *S. typica*, it was more abundant in dredge samples.

Salinities and temperatures where this shrimp was found ranged from 30.24 to 36.47 ‰ and from 18.0 to 31.0°C. Lyons et al. (1971) encountered it at 22 to 32 ‰ and 17 to 30°C in depths of 3 m off Crystal River, Florida. In the Apalachee Bay region of northwest Florida, it was found in salinities from 25.0 to 37.0 ‰ (Menzel, 1956). Camp et al. (1977) reported 35 to 36 ‰ and 25.4 to 32.0°C, for specimens on the Florida east coast.

Preferred substrate for *S. laevigata* has been generally characterized as shelly bottom. Lunz (1945) reported that this shrimp was often captured during dredging over shell bottoms in most rivers and harbors of South Carolina. Although Wass (1955) reported dredging one specimen in soft mud, he and other authors (Hay and Shore, 1918; Rouse, 1969; Camp et al., 1977) have related most captures to harder, coarser substrates.

No seasonal patterns were revealed from our limited collections; 67% of specimens were caught during the final five months of sampling, August through November, 1967. Menzel (1956) reported that specimens occurred year round in Apalachee Bay, Florida.

Seven times more *S. laevigata* were captured at night than during day at Stations B and C. Camp et al. (1977) reported similar results off Hutchinson Island, Florida.

At Hourglass stations, dredging for this species was over three times more effective than trawling. Lunz (1945) found dredging to be a highly effective collection method in South Carolina. This species was also common in the extensive grass beds north of Clearwater, Florida, and was often caught in bait shrimp

TABLE 18. *Sicyonia laevigata*: MONTHLY OCCURRENCES AT HOURGLASS STATIONS. TRAWL CAPTURES (TOP NO.), DREDGE CAPTURES (BOTTOM NO.).

Sicyonia laevigata

STA	1965					1966													1967											TOT
	A	S	O	N	D	J	F	M	A	M	J	J	J sp	A	S	O	N	D	J	J sp	F	M	A	M	J	J	A	S	O	N	
A								3	1																						3 1
B_1										1														1		1	1			1 7	1 11
B_2																												1		1	2
C_1						1																							1		2
C_2																															
D_1																															
D_2																															
E																															
I				1				2 1									1						1			1		4		2	3 10
J																															
K																															
L																															
M																															
TOT				1		1		5 1	1	1							1						1	1		2	1	5	1	1 10	7 26

trawls there and in lower Tampa Bay (Lyons et al., 1971). Evidently *S. laevigata* shows some preference for grass habitats in estuarine and nearshore environments, associating with coarse substrates further offshore where seagrasses are absent.

Meager collections of this shrimp would not allow conclusions regarding age and growth from size frequencies. Small and large specimens were found year-round. The smallest specimen was captured in September and the largest in October. There was a positive correlation in Hourglass collections between increasing distance and depth offshore and carapace length, suggesting an ontogenetic migration.

Overall male/female sex ratio was 0.58. In dredge samples it was similar (0.57), with 36% of females larger than the largest male.

Male sexual maturity was attained at a very small size; female maturity was unassessed. Only one male (2.0 mm CL) had unjoined petasmal endopods while all larger males (2.9-4.9 mm CL) had joined petasmata indicating maturity was reached around 3.0 mm CL.

Stomach contents of five Hourglass *S. laevigata* were examined. Of these, only one large female (12.2 mm CL) from a night dredge at Station C had a full stomach. Several large fragments of a shrimp-like crustacean, a nephtyid polychaete, gastropods and two nematodes had been consumed. The four remaining specimens (three collected at night, one during daytime) had little in their stomachs (echinoid and molluscan fragments).

Although diel sampling at Station B suggested nocturnal activity, there were too few specimens captured to be certain. Stomachs of six large adults collected at night by bait shrimpers from grass flats in lower Tampa Bay and off the Pithlachascotee River also were examined. All of these shrimp had empty stomachs. Thus, *S. laevigata* is apparently a diel, benthic feeding carnivore.

Sicyonia stimpsoni Bouvier, 1905

Figure 39

Sicyonia stimpsoni Bouvier, 1905, p. 748; Eldred et al., 1965, pp. 3, 32; Bullis and Thompson, 1965, p. 7 [part]; Joyce and Eldred, 1965, p. 24; Cobb, 1971, pp. 104, 109-111; Wood, 1974, p. 40, pl. 8, fig. 6.

Sicyonia dorsalis: Milne Edwards and Bouvier, 1909, pp. 253-256, pl. 8, figs. 4-13 [not *Sicyonia dorsalis* Kingsley, 1878].

Eusicyonia stimpsoni: Burkenroad, 1934a, pp. 73, 96, 98; 1934b, pp. 117, 121, 123-125; 1939, pp. 57, 58; ?Pearson, 1939, pp. 61-71, figs. 55-66; Lunz, 1945, pp. 9, 10, fig. 6 [part]; Williams, 1965, pp. 33, 38 [part]; Cobb, 1971, pp. 109, 110.

Material examined: HOURGLASS STATION E: 1 unsexed, 1.7; 1 September 1966; dredge; FSBC I 16629. — 1 (lost); 2 August 1967; trawl; FSBC I 6616. — 1♀, 3.4; 1 damaged, 4.5; 6 October 1967; dredge; FSBC I 16229. — HOURGLASS STATION M: 1♂, 3.0; 14 January 1966; trawl; FSBC I 16628. — 1 damaged, 7.7; 14 January 1966; dredge; stomach content; FSBC I 16663. — 1♂, 6.9; 2 unsexed, 1.8, 2.6; 5 September 1966; dredge; FSBC I 4503.

Diagnosis: Rostrum elevated, with three dorsal teeth, bifid tip. Postrostral carina with small tooth anterior to hepatic spine, large tooth posterior to hepatic spine. Antennal angle armed with small unbuttressed spine. Ischium of first pereopod unarmed. Fourth abdominal pleura with anteroventral margin rounded, posteroventral margin angular, both unarmed.

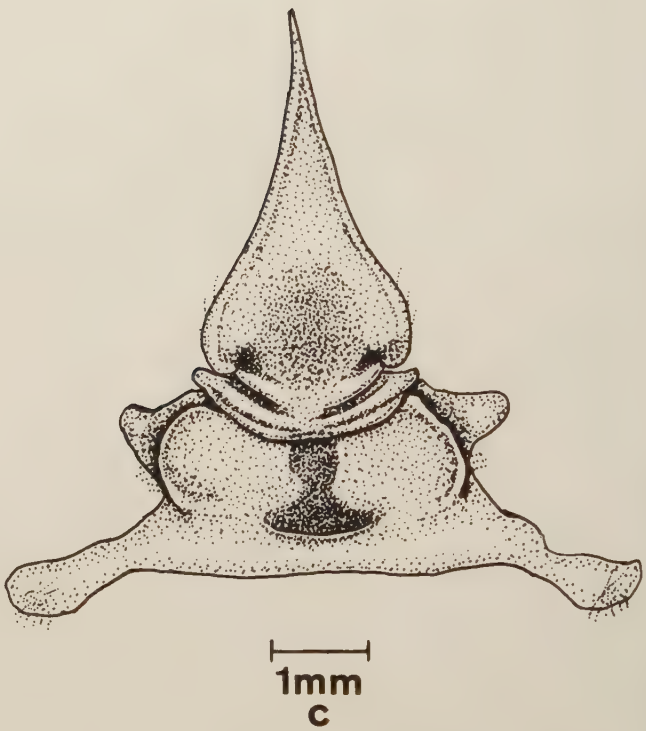


Figure 39. *Sicyonia stimpsoni*: a. ♂, 6.9 mm CL, ventral appendages omitted, FSBC I 4503. b. ♂, 6.9 mm CL, petasma, FSBC I 4503; c. ♀, 12.7 mm CL, thelycum, FSBC I 3350.

Description: Rostrum not overreaching antennular peduncle, slightly tapered distally, elevated above carapace; three dorsal teeth behind bifid tip, posterior tooth anterior to posterior orbital margin; ventral margin with or without subapical tooth; distinct adrostral carina. Postrostral carina low, with small tooth anterior to hepatic spine, large tooth posterior to hepatic spine by about half distance to posterior margin of carapace. Orbital margin unarmed. Antennal spine small, slender. Branchial region traversed by longitudinal sulcus originating below hepatic spine, not reaching posterior margin of carapace. Hepatic spine well developed, buttressed. Ventral submarginal carina on carapace.

Antennular peduncle just overreaching scaphocerite. Stylocerite setose laterally, terminating in slender tooth. First antennular segment armed with distolateral spine reaching to about mid-length of second segment. Second segment about twice length of third. Mesial antennular flagellum about same length of peduncle; mesial flagellum about 60% length of lateral flagellum, setose distally.

Scaphocerite length twice width, just reaching distal end of second antennular segment; distal tooth overreaching lamella. Medial margins densely set with long setae. Basicerite with distolateral tooth, small triangular projection ventral to tooth. Carpocerite setose, half length of scaphocerite. Antennal flagellum finely setose along entire length; length not quite twice carapace length.

Third maxilliped overreaching carpocerite by half length of dactyl. First pereopod slightly overreaching distal margin of basicerite. Second pereopod reaching to about 0.66 length of carpocerite. Third pereopod reaching to distal margin of scaphocerite. Fourth pereopod slightly overreaching pterygostomian corner of carapace. Fifth pereopod reaching mid-length of basicerite. Ischium of first pereopod unarmed.

Abdominal somites sculptured, finely pubescent, with high mesial carina cleft posteriorly on first five somites; single, posteriorly directed teeth on fifth and sixth somites. Carina of first somite produced into large, anteriorly directed tooth. Ventral margins of pleura bordered by smooth, narrow ridge. First four pleura broadly rounded posteriorly, angulate anteroventrally. Fifth pleuron rounded anteriorly; posteroventral margin armed with posteriorly directed tooth. Sixth pleuron angular anteriorly, ventral margin straight, posteroventral angle with tooth. First three somites with anteromedian and posteromedian sulcus well defined. Anteromedian sulcus less defined on fourth somite, rudimentary or absent on fifth; pleuron of sixth somite untraversed by definite sulci. Posterior margins of fourth and fifth somites with V-shaped indentations. Sixth somite with subrectangular lobe on posterior margin; shallow, longitudinal sulcus on dorsal surface. Telson long, tapered to strong point, flanked by two short, subterminal spines. Dorsal surface and lateral margins finely pubescent, with longitudinal median sulcus well expressed to base of subterminal spines. Telson tip slightly exceeds posterior margin of mesial ramus of uropod, mesial ramus slightly exceeds margin of lateral ramus. Lateral ramus armed with a stout, distolateral spine which does not exceed posterior margin of ramus.

Thelycum with median process (sternite XIII) separated from transverse plate (sternite XIV) by finely defined transverse groove. Median process arising as concave, flask-shaped plate, projecting anteriorly as slender spine to level of anterior base of second pereopod. Median process mesially concave, rising posteriorly to form anterior lip of transverse groove. Transverse plate deeply concave anteromesially with short transverse ridge at posterior margin of concavity. Transverse plate produced mid-laterally as large, raised, flat lobes.

Median process (sternite XIII) of males concave, posteriorly as well as along entire length. Marginal carina merging anteriorly to form tip extending beyond posterior margin of tenth sternite. Petasma gaping proximally; distolateral corners produced laterally as cornuate tooth. Distal dorsomedian lobule curved medially; distolateral corners of dorsal lobules produced anteriorly.

Appendix masculina overlying base of petasma; club-shaped termination setose on median border. Endopod of second pleopod appearing as small obtuse lamina fringed with setae.

Geographic and bathymetric range: North Carolina to Florida; eastern Gulf of Mexico; Cuba; Virgin Islands; Barbados; Panama and Colombia. Depth range 73-411 m.

Remarks: Seven specimens (1.7-7.4 mm CL) were found during regular Hourglass sampling; all but one were dredged. An additional shrimp (7.7 mm CL) was recovered from the stomach of a scorpion fish (*Scorpaena agassizi*, 103 mm SL) dredged at Station M.

Pearson (1939) reared eggs and postlarvae he identified as *Sicyonia stimpsoni*. These planktonic forms were captured in Ft. Pierce and St. Augustine Inlets on Florida's east coast. However, Cook and Murphy (1965) thought that two stages described by Pearson were second and third mysis stages of other *Sicyonia* species. Cobb (1971) speculated that these shrimp may have been *S. burkenroadi*, based on the presence of an elongate spine on the ventral margin of the first five abdominal pleura of mysis stages. Dr. Robert Gore (Harbor Branch Foundation, personal communication) has found juvenile *S. stimpsoni* offshore of Jupiter Inlet, Florida east coast, in 50 m and believes that inlet occurrences would be unusual for this species. Thus, specific identity of Pearson's specimens has yet to be established.

Salinity and temperature where our specimens were captured ranged from 36.14 to 36.53 ‰ and 19.0 to 21.5°C.

Sicyonia typica (Boeck, 1864)

Figure 40

?*Palaemon carinatus* Olivier, 1811, p. 667.

Sicyonia carinata Milne Edwards, 1830, pp. 344-346, pl. 9, fig. 9; Kingsley, 1880, pp. 426, 427; Kingsley, 1899, p. 719 [not *Cancer carinatus* Brünnich, 1768].

Synhimantites typicus Boeck, 1864, p. 189.

Sicyonia edwardsi Miers, 1881, p. 367; Milne Edwards and Bouvier, 1909, pp. 244, 251-253.

Eusicyonia edwardsi: Burkenroad, 1934a, pp. 71-73, 85, 86, 88, 90, 92; Anderson and Lindner, 1945, p. 315; Lunz, 1945, pp. 4, 7, 8, fig. 4.

Sicyonia typica: Hildebrand, 1954, pp. 268, 270, 325; Voss, 1955, p. 11, fig. 25; Wass, 1955, pp. 132, 143; Menzel, 1956, p. 41; Springer and Bullis, 1956, p. 10; Eldred, 1959, p. 5; Tabb and Manning, 1961, p. 595; Tabb et al., 1962b, pp. 61, 62; Saloman, 1964, p. 160; Bullis and Thompson, 1965, p. 7; Eldred et al., 1965, pp. 3, 32; Holthuis and Rosa, 1965, p. 7; Joyce and Eldred, 1966, p. 24; Rouse, 1969, p. 136; Lyons et al., 1971, p. 28; Wood, 1974, p. 40, pl. 8, fig. 4; Brusher and Ogren, 1976, pp. 158, 161.

Material examined: HOURGLASS STATION A: 1♂, 8.1; 3 December 1965; dredge; FSBC I 1326. — 1♀, 7.5; 7 February 1966; dredge; stomach content; FSBC I 7044. — 1♂, 13.4; 6 April 1966; dredge; FSBC I 6623. — 1♀, 4.8; 6 June 1966; dredge; FSBC I 6646. — 1♂, 4.1; 1♀, 4.2; 31 August 1966; dredge; FSBC I 8067. — 1♀, 15.3; 3 April 1967; dredge; FSBC I 6625. — 1♀, 3.5; 1 August 1967; dredge; FSBC I 8075. — HOURGLASS STATION B: 1♀, 12.0; 30 August 1965; trawl; FSBC I 834. — 2♂, 3.5, 8.7; 17 June 1966; dredge; FSBC I 6624. — 1♂, 5.8; 10 July 1966; dredge; FSBC I 3214. — 1♀, 8.7; 1 August 1966; dredge; FSBC I 8065. — 1♂, damaged; 10 August 1966; dredge; FSBC I 8066. — 2♀, 6.9, 7.6; 31 August 1966; dredge; FSBC I 3965. — 1 unsexed, 1.8; 8 October 1966; dredge; FSBC I 15287. — 1♀, 7.5; 18 October 1966; dredge; FSBC I 4653. — 1♀, 8.0; 6 November 1966; dredge; FSBC I 6641. — 1♀, 3.3; 19 November 1966; dredge; FSBC I 8068. — 1♀, 12.0; 1 December 1966; trawl; FSBC I 6626. — 1♂, 9.3; 1♀, damaged; 1 December 1966; trawl; stomach content; FSBC I 7042. — 1♂, 5.0; 1 December 1966; trawl; stomach content; FSBC I 7046. — 1♀, 2.7; 1 damaged, 4.5; 6 January 1967; dredge; FSBC I 7040. — 1♂, 10.1; 25 January 1967; trawl; FSBC I 6617. — 1♀, 15.5; 27 February 1967; dredge; FSBC I 6629. —

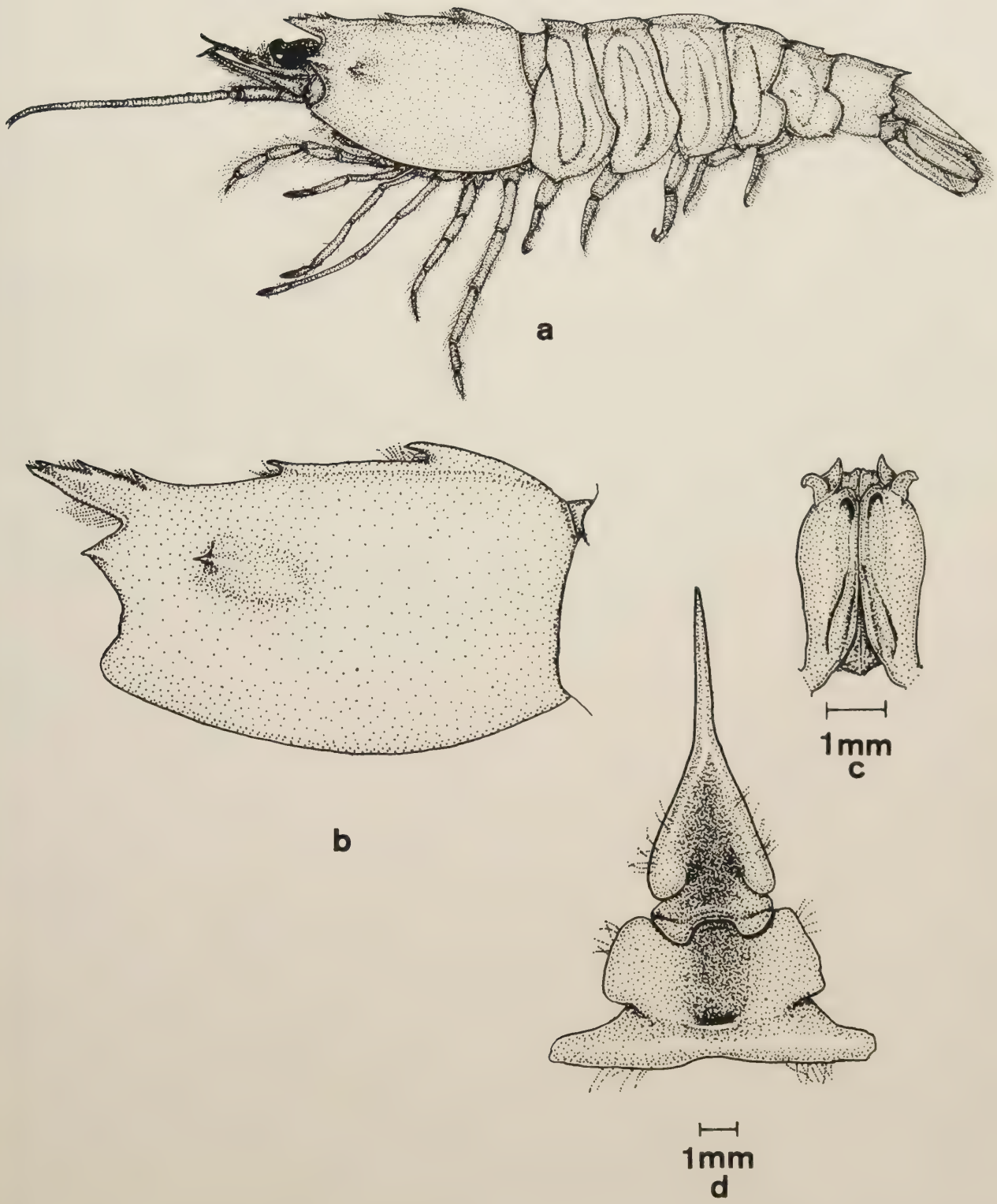


Figure 40. *Sicyonia typica*: a. ♀, 16.3 mm CL, FSBC I 16712; b. ♀, 8.1 mm CL, carapace, FSBC I 4003; c. ♂, 13.5 mm CL, petasma, FSBC I 16712; d. ♀, 16.3 mm CL, thelycum, FSBC I 16712.

1♀, damaged; 2 March 1967; trawl; FSBC I 6642. — 2♀, 5.0, 16.0; 3 April 1967; dredge; FSBC I 6628. — 1♂, 4.0; 1♀, 4.5; 1 July 1967; dredge; FSBC I 8073. — 2♂, both 6.9; 3♀, 2.6-9.8; 1 unsexed, 1.6; 1 August 1967; dredge; FSBC I 6632. — 1 unsexed, 2.0; 11 August 1967; dredge; FSBC I 15288. — 1 unsexed, 2.0; 1 damaged, 3.0; 31 August 1967; dredge; FSBC I 16631. — 2 damaged; 11 September 1967; dredge; FSBC I 8077. — 1♀, 6.9; 5 October 1967; dredge; FSBC I 6627. — 1♀, 7.9; 25 October 1967; dredge; FSBC I 6630. — 4♂, 3.0-6.8; 9♀, 2.2-9.1; 2♀, damaged; 1 unsexed, 1.5; 5 damaged; 2 November 1967; dredge; FSBC I 6725. — 1♀, 5.3; 20 November 1967; dredge; FSBC I 6635. — HOURGLASS STATION C: 1♀, 4.0; 3 April 1967; trawl; FSBC I 8071. — 1 damaged; 11 May 1967; dredge; FSBC I 8070. — HOURGLASS STATION I: 1♀, 11.1; 5 August 1966; trawl; FSBC I 6643. — 2♀, 2.4, 3.5; 14 November 1967; dredge; FSBC I 6640. — HOURGLASS STATION J: 1♀, 13.4; 21 March 1966; dredge; FSBC I 2248. — 1♂, 1.6; 4♀, 2.0-2.9; 5 July 1966; dredge; FSBC I 7043. — 1♂, 3.6; 21 July 1966; trawl; stomach content; FSBC I 7041. — 1♂, 3.2; 21 July 1966; trawl; stomach content; FSBC I 7045. — 1♀, 8.1; 4 September 1966; dredge; FSBC I 4003. — 1♀, 13.1; 12 January 1967; trawl; FSBC I 6631. — 5♀, 12.1-17.3; 30 January 1967; trawl; FSBC I 6620. — 1♀, 7.3; 15 February 1967; dredge; FSBC I 6633. — 2♂, 11.9, 12.2; 1♀, 17.1; 8 March 1967; dredge; FSBC I 6615. — 1♀, 6.3; 5 July 1967; dredge; FSBC I 6639. — 1♀, 4.0; 11 October 1967; trawl; stomach content; FSBC I 16662. — 2♀, 4.3, 12.5; 1 damaged, 2.9; 14 November 1967; trawl; stomach content; FSBC I 16661. — 1 unsexed, 2.4; 14 November 1967; dredge; FSBC I 16630. — HOURGLASS STATION K: 1♀, damaged; 12 June 1966; trawl; FSBC I 6644. — 1♀, 4.9; 6 June 1967; dredge; FSBC I 8072. — 1 unsexed, 3.9; 4 September 1967; dredge; FSBC I 8981.

Diagnosis: Rostrum with one or two dorsal teeth, bifid tip, variably elevated to 45°. Postrostral carina with two, sometimes three teeth, two large and posterior to hepatic spine. Antennal spine well developed, buttressed. Ischium of first pereopod unarmed.

Description: Rostrum not overreaching anterior margin of cornea, tapered distally, elevated as much as 45°, rarely horizontal; dorsal margin straight, armed with one tooth, occasionally with two teeth exclusive of bifid tip; dorsal and ventral teeth of tip subequal or with ventral tooth slightly overreaching dorsal tooth. Postrostral carina of moderate height, armed with two large teeth posterior to level of hepatic spine, one small tooth anterior to level of hepatic spine and often displaced anteriorly on rostrum. Antennal spine short, buttressed; hepatic spine well developed.

Antennular flagella approximately same length as antennular peduncle. Mesial flagellum slightly shorter than lateral flagellum.

Length of scaphocerite about 1.5 maximum width; spine exceeding distal edge of scale, reaching to about proximal one-fifth of antennular flagella. Antennal flagellum length twice carapace length.

Third maxilliped slightly overreaching base of antennal flagellum, not exceeding distal end of scaphocerite; length of dactyl about 60-70% length of propodus. First pereopod reaching base of carpocerite. Second pereopod exceeding distal end of carpocerite by half length of dactyl. Third pereopod overreaching base of antennal flagellum by at most one-third length of dactyl. Fourth pereopod reaching edge of pterygostomian corner of carapace. Fifth pereopod reaching carpocerite. No spination on pereopods.

Abdominal somites with high, mesial tergal carinae, produced as large anteriorly directed tooth on first somite and single, posteriorly directed teeth on somites five and six. Ventral posterior margins of pleura of second through fourth somites rounded; somites five and six with ventral margins straight, single spines on posteroventral angles. Ventral anterior angles of first four somites increasingly produced with increasing carapace length. First three somites traversed by distinct, anteromedian and posteromedian pleural sulci,

converging ventrally; shallow, posterior pleural sulcus present. Telson with median sulcus which shallows posteriorly. Mesial and lateral rami of uropod terminate at about same level as telson tip. Telson tip may slightly exceed rami on smaller specimens. Lateral ramus with distolateral spine which does not exceed posterior margin of ramus.

Median process (sternite XIII) of thelycum with length about 2.5 width, extending anteriorly as lanceolate spine to level of anterior base of second pereopods; concave mesially, posterior half expanded laterally, distinctly bilobed, posterolateral corners curved dorsomedially. Transverse plate (sternite XIV) with bosses curved anterolaterally, angulate posterolaterally; mesial concavity deep and blends uniformly with mesial concavity of median process, without prominent anterior margin.

Ventral lobules of petasma gaping proximally, lateral margins narrow posteriorly, subparallel, entire, longitudinal folds of posteromedial angles reaching to near midpoint of ventral lobules; anteromedian corners obtuse, with sub-marginal depressions; anterolateral corners each with large, cornuate tooth directed laterodorsally. Distomedial corner of dorsal lobule with large, cornuate tooth directed dorsomedially.

Appendix masculina fringed with submarginal setae, terminating in scyphiform bud with posterior portion of rim elevated. Endopod of second pleopod appearing as small obtuse lamina, slightly longer than appendix masculina; margin setose.

Color of fresh specimens: Entire dorsum of large juveniles and adults ornamented with continuous mosaic pattern of dark bluish-brown, reddish-beige, and white reaching ventrally to branchiostegal region of carapace and pleura of abdomen. Branchiostegal region, pleura, legs and ventral side of body white. Dorsum of small juveniles with distinct alternating bands of dark bluish-gray and white. Dark band traversing anterior border of carapace and eyestalks, middle of carapace, posterior border of carapace, entire tergum of abdominal somite two and anterior part of tergum of somite three, tergum of somite four, and entire tergum and pleura of somite five. Blue spot near distal margin of telson; large, oval spot of dark blue on lateral rami of uropod, uropods flecked with orange.

Morphological variation: Morphological variation in the population represented by Hourglass *S. typica* was notable, consisting mainly of ontogenetic changes in rostral length and elevation, placement of teeth on the postrostral carina, and spination on ventral margins of abdominal pleurae. These characters were not related to sexual dimorphism; they often varied irregularly among individuals of similar size, but generalizations regarding changes with growth were possible.

Relative rostral length generally increased with increasing size. The rostral tip was posterior to the posterior border of the eye among 70% of the individuals 2.0 mm CL or smaller; this condition was found among shrimp up to 10.0 mm CL. All shrimp larger than 10.0 mm CL had the rostral tip extending to or slightly overreaching the posterior border of the cornea, although this condition was distributed among all size categories.

Angle of elevation of the ventral margin of the rostrum ranged from 0° to 45° and was largely proportional to size, although quite variable among shrimp of comparable size. The angle of rostral elevation ranged between 0° and 15° for shrimp 3.0 mm CL or less and between 15° and 45° for larger individuals.

The dentition formula for the postrostral carina-rostrum was either 2 + 2 or 3 + 1; only individuals less than 7.0 mm CL had a formula of 2 + 2. Among shrimp 2.0 mm CL or smaller, the 2 + 2 form predominated. Thus, the posterior tooth of the rostrum appears to move posteriorly to the level of the orbital margin with growth. The posterior tooth of the postrostral carina was anterior to the posterior border of the

carapace by 0.25 to 0.33 CL among shrimp 3.0 mm CL or smaller. With increasing size, this tooth became more posteriorly placed until it reached the posterior carapace margin on all individuals 6.0 mm CL or larger.

Shrimp smaller than 7.0 mm CL showed no trace of nodes or spines on the ventral margin of the first four abdominal pleurae. With increasing size (7.0 to 17.0 mm CL) nodes became evident, and a distinct spine was present on the ventral margin of the first four pleurae among individuals larger than 17.0 mm CL.

Geographic and bathymetric range: Beaufort, North Carolina southward through the Gulf of Mexico; West Indies to Santa Catarina Island, Brazil (26° 53′S; Mistakidis and Neiva, 1966). Shallow water to 68 m.

Remarks: Ninety-one *Sicyonia typica* (1.5-17.3 mm CL) were caught during Hourglass sampling (Table 19); an additional four specimens were recovered from fish stomachs. More abundant on the northern transect, this species was more numerous in dredge than in trawl samples. Intertransect distribution was similar, with most occurrences at 18 m stations (Figure 41).

Sicyonia typica was reported to Hildebrand (1954) as being found in commercially exploitable quantities in the Gulf of Campeche. He also reported commercial exploitation off the southwest coast of Cuba. However, Pérez Farfante (1954) stated in reporting on commercial shrimps of Cuba that *S. typica* appeared associated with *Penaeus notialis*; although noting that the shrimp possessed delicate flavor, she did not indicate that it was commercially exploited.

Hourglass specimens were found in salinities ranging from 32.42 to 36.45 ‰. Tabb and Manning (1961) stated that *S. typica* apparently prefers high salinity; they found it between 26 and 37 ‰. Tabb et al. (1962b) reported *S. typica* as only found in salinities above 28 ‰. Rouse (1969) observed occurrences in salinities of 31-34 ‰. Low salinity water was concurrently sampled in all these southwest Florida studies, indicating a definite preference by the species for high salinity water.

Temperatures where *S. typica* occurred in our study area ranged from 16.5 to 31.0°C. Rouse (1969) reported a temperature range of 16-24°C in southwest Florida.

TABLE 19. *Sicyonia typica*: MONTHLY OCCURRENCES AT HOURGLASS STATIONS. TRAWL CAPTURES (TOP NO.), DREDGE CAPTURES (BOTTOM NO.).

Sicyonia typica																														
STA	1965					1966													1967											TOT
	A	S	O	N	D	J	F	M	A	M	J	J	J sp	A	S	O	N	D	J	J sp	F	M	A	M	J	J	A	S	O	N	
A					1				1		1				2								1				1				7
B_1		1												1	2	1	1	1				1	2			2	6	2	1	21	4 41
B_2											2	1		1		1	1				1						1	2	1	1	12
C_1																							1	1							1 1
C_2																															
D_1																															
D_2																															
E																															
I														1																	1 2
J								1				5				1			1	5	1	3				1			2		6
K											1																		1		13
L																									1			1			1 2
M																															
TOT		1			1			1	1		1 3	6		1 2	5	2	2	1	1 2	6	2	1 3	1 3	1	1	3	8	5	2	25	13 78

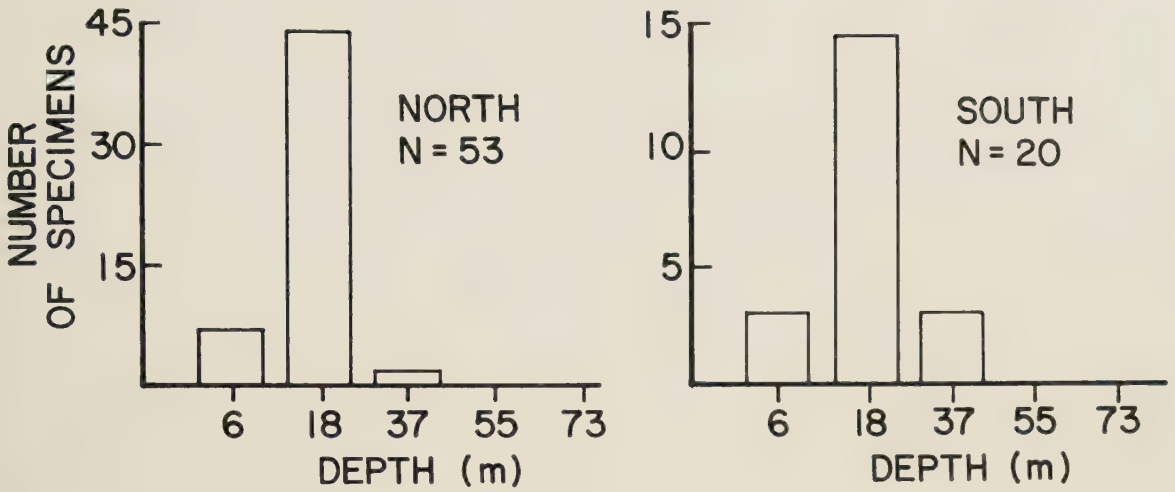


Figure 41. *Sicyonia typica*: Abundance at stations on north and south transects during regular sampling.

Substrates where *S. typica* was most abundant (18 m) consisted primarily of quartz and shell sand, occasionally penetrated by limestone outcroppings. Off Cuba's southwest coast, the species occurs in commercial catches of *Penaeus notialis* on "very soft to firm mud, sand and mud, and predominantly sand patches among rock" (Pérez Farfante, 1969). *Sicyonia typica* was strongly associated with the bottom, being six times more abundant in dredge samples.

No trends of seasonal abundance were evident from our limited collections (Figure 42). Peak occurrences were in July 1966 (southern transect) and November 1967 (northern transect).

Diel sampling at Station B yielded nearly four times more shrimp at night (45 night, 12 day) indicating, as did diet analysis, that *S. typica* was nocturnal. Its preponderant abundance in night-time dredge samples indicated little response to habitat or substrate disturbances; a usual escape response e.g., rapid propulsion from the substrate as is typical of *Penaeus* species, appears lacking for *S. typica*. Relatively high success of diurnal dredging further indicated a close association with substrate; overall, 86% of Hourglass specimens were dredged. Paucity in day and night trawls may be caused by its preference for substrate near exposed limestone rocks where trawls would snag with possible net and sample loss.

Inadequate sample sizes prevented analysis of size frequencies and consequent age/growth assessments. However, smallest specimens were encountered in July, and shrimp sizes generally increased through winter months to April. Small specimens were also recruited in November, indicating summer and fall reproductive activity.

Females far outnumbered males; the overall ratio excluding special trawl samples was 0.31. Sex/size disparity was smaller than most other non-commercial Hourglass penaeoidea (13% of females were larger than the largest male, 13.4 mm CL).

Ovaries of *S. typica* were not excised to determine sexual development stages. However, male maturity was assessed, based on coupling of petasmal endopods. Smallest individuals with joined petasmata were 3.2 and 3.6 mm CL. Petasmata of other males measuring 3.3, 3.5 and 4.0 mm CL were unjoined. All individuals larger than 4.0 mm CL had joined endopods and were judged sexually mature.

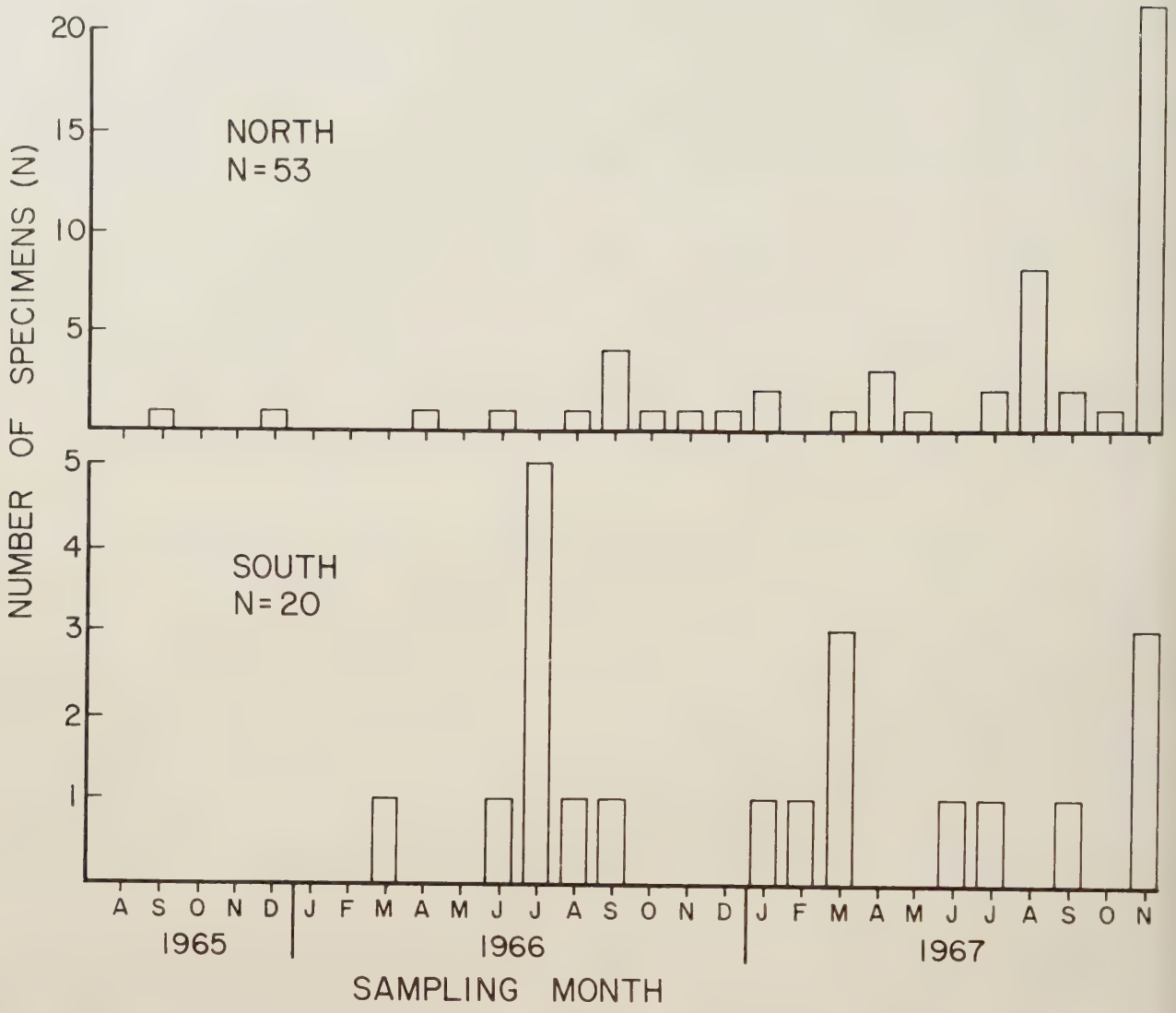


Figure 42. *Sicyonia typica*: Intertransect monthly abundance during regular sampling.

Stomach contents of 16 large specimens (12.0-17.1 mm CL) from night sampling (Stations A, April; B, April and September; J, January and March) and one shrimp (15.5 mm CL) from day sampling (Station B, February) were examined (Table 20). Five shrimp caught during regular night sampling had empty stomachs but were captured in very early evening, possibly before they had begun active feeding. The specimen caught during daylight sampling had an empty stomach. Mollusks were found either predominantly or residually in nine stomachs (82%) and crustaceans were found, mostly residually, in eight stomachs (73%); both groups were obvious major components of the diet. The most abundant mollusks were the sand dwelling gastropods *Natica pusilla* Say, *N. canrena* (Linné) and *Eulimostraca hemphilli* (Dall); one *Caecum imbricatum* Carpenter, was observed. A variety of crustaceans (harpacticoid copepods, isopods, amphipods, mysids and a decapod) occurred in stomachs, but specific identification was not possible because of deterioration. Ophiuroid parts dominated one stomach. Foraminifera and nematodes comprised a small, consistent dietary portion. *Sicyonia typica* appeared to be a generalized, benthic, nocturnal carnivore with possible selectivity toward gastropods and small crustaceans.

TABLE 20. *Sicyonia typica*: FOOD ITEM CONTENT AND COMPOSITION IN 17 STOMACHS.

Item	Predominant		Residual		Total	
	N	%*	N	%*	N	%*
Foraminiferida	0	—	4	36	4	36
Nematoda	0	—	4	36	4	36
Polychaeta	0	—	1	9	1	9
Mollusca						
Bivalvia	1	9	0	—	1	9
Gastropoda	6	54	2	18	8	72
Crustacea						
Unidentifiable fragments	1	9	2	18	3	27
Copepoda	0	—	1	9	1	9
Mysidacea	0	—	1	9	1	9
Isopoda	0	—	1	9	1	9
Amphipoda	0	—	1	9	1	9
Decapoda	0	—	1	9	1	9
Bryozoa	0	—	1	9	1	9
Echinodermata	1	9	1	9	2	18
Pisces	0	—	2	18	2	18
Empty					6	35**

*Percent of total stomachs (11) containing food.
**Percent of total stomachs (17) examined.

Sicyonia typica was recovered from stomachs of three dusky flounders (*Syacium papillosum*). One flounder (158 mm SL) had consumed two specimens (♀, 4.3 mm CL; damaged, 2.9 mm CL). Two other flounders of unknown length each had one female in their stomachs (4.0, 12.5 mm CL). All three fish were trawled at Station J in October and November. Presence of *S. typica* in only flounder stomachs may be a further indication of the shrimp's intimate association with sand substrates.

Family Sergestidae Dana, 1852
Genus *Lucifer* Thompson, 1829

Lucifer faxoni Borradaile, 1915

Figure 43

Lucifer faxoni Borradaile, 1915, p. 228; Burkenroad, 1934b, pp. 61, 132-134; Wass, 1955, pp. 131, 143; Menzel, 1956, p. 41; Tabb and Manning, 1961, p. 595; Hopkins, 1966, pp. 15, 29, 33, 38, 42, 47, 48; Woodmansee, 1966, pp. 847-850; Kelly and Dragovich, 1968, pp. 209, 215, 216, 220; Rouse, 1969, p. 136; Lyons et al., 1971, p. 28; Franks et al., 1972, pp. 1, 28-33, 43; Hopkins, 1977, p. 471.

Material examined: HOURGLASS STATION A: 1♂; 3 August 1965; trawl; FSBC I 16836. — 1♂; 11 May 1967; dredge; FSBC I 16837. — 1♀; 5 October 1967; trawl; FSBC I 16831. — 29♂; 12♀; 10 damaged; 5 October 1967; dredge; FSBC I 16828. — HOURGLASS STATION C: 1♀; 5 February 1967; dredge; FSBC I 16829. — 17♂; 27♀; 3 April 1967; dredge; FSBC I 16832. — HOURGLASS STATION D: 1♂; 1♀; 4 April 1967; dredge; FSBC I 16833. — HOURGLASS STATION I: 1♂; 1♀; 6 August 1965; trawl; FSBC I 16835. — 2♂; 1♀; 6 June 1967; trawl; FSBC I 16830. — 1♂; 3♀; 4September 1967; dredge; FSBC I 16834. — 3♂; 14 November 1967; dredge; FSBC I 16838.

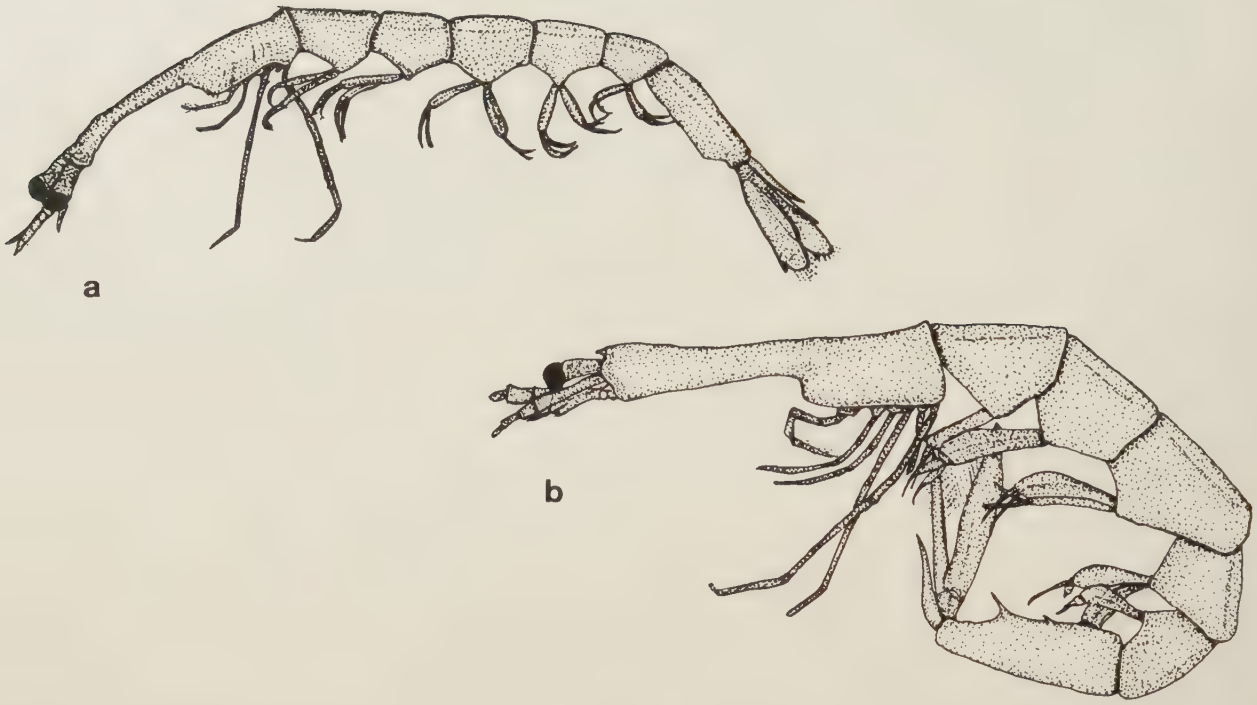


Figure 43. *Lucifer faxoni*: a. ♀, 1.5 mm CL, FSBC I 16828; b. ♂, 2.2 mm CL, FSBC I 16828.

Diagnosis: Eye stalks short, with ocular margin considerably shorter than distal end of first antennular segment. Termination of petasma smooth, acute, ventral process slender and acute. Exopod of uropod 4.0 to 5.0 times width, with marginal spine terminating just before or slightly beyond lateral distal margin of exopod (modified from Hansen, 1919).

Description: Williams, 1965, pp. 40, 41.

Geographic and bathymetric range: Nova Scotia southward through the Gulf of Mexico to Rio de Janeiro, Brazil; Bermuda; Bahamas; Antilles; Gulf Stream in the North Atlantic; Senegal, Africa.Surface to 91 m in coastal waters; epipelagic in oceanic environments.

Remarks: One hundred thirteen adult *L. faxoni* were captured during our sampling, primarily in two night dredge hauls at Stations A and C (Table 21). Camp et al. (1977) reported similar patchy occurrence in benthic trawls on Florida's east coast.

Salinities and temperatures of capture were 34.97-36.30 ‰ and 17.0-30.5°C. Preference for higher salinities and temperatures has been indicated in other studies (Menzel, 1956; Tabb and Manning, 1961; Franks et al., 1972). Hopkins (1966) showed that *L. faxoni* in St. Andrew Bay, northwest Florida, decreased in biomass with decreasing salinity and was scarce or absent from samples during colder months (December through April).

Woodmansee (1966) detailed diel tide-related vertical migrations of this plankter off Mississippi Sound. His data indicated a pattern of movement in the water column allowing transport to nearshore areas. A characteristic movement toward the bottom occurred on ebbing tides which augmented landward transport

TABLE 21. *Lucifer faxoni*: MONTHLY OCCURRENCES AT HOURGLASS STATIONS. TRAWL CAPTURES (TOP NO.), DREDGE CAPTURES (BOTTOM NO.).

Lucifer faxoni

STA	1965					1966													1967										TOT
	A	S	O	N	D	J	F	M	A	M	J	J	J sp	A	S	O	N	D	J	J sp	F	M	A	M	J	J	A	S	O	N	
A	1																					1							1 51		1 52
B_1																															
B_2																															
C_1																					1		44								45
C_2																															
D_1																							2								2
D_2																															
E																															
I	2																							3				4		3	5 7
J																															
K																															
L																															
M																					1										
TOT	3																				1		46	1	3			4	1 51	3	7 106

during flood tides. However, occurrences in our dredge samples (90% of captures) could not be correlated with a similar pattern.

Camp et al. (1977) caught most *L. faxoni* in benthic trawls on Florida's east coast but did not consider this species part of the benthic arthropod assemblage; captures probably resulted from the trawl intercepting swimming swarms of shrimp (D.K. Camp, personal communication). In Tampa Bay, Kelly and Dragovich (1968) caught mostly larval forms in a 0.5 m plankton net (1.024 mm mesh). This species was the most abundant zooplankter in their sampling. However, their large mesh size left much plankton unfiltered; *L. faxoni* is definitely not a dominant zooplankter in Tampa Bay (Hopkins, 1977).

Male/female ratio was 1.2 (56♂, 47♀). Burkenroad (1934b) reported a preponderant male ratio, but Chace (1972) indicated an even ratio for West Indian populations.

Spawning times were not indicated in our collections. In Bogue Sound, North Carolina, ovigerous females were found throughout summer (Williams, 1965). Larval forms appeared year-round in Tampa Bay (Kelly and Dragovich, 1968), indicating probable continuous spawning in that area.

Burkenroad (1934b) described reproductive systems of both sexes. He found that males carried one spermatophore, an apparent adaptation to extreme lateral compression. Chace (1972) noted considerable variability of petasmal development as related to shrimp size, and found a very small ovigerous female (1.8 mm CL). He suggested that more study was needed to determine if this variation was characteristic of *L. faxoni* or indicated possible presence of another species.

DISCUSSION

Most Hourglass Penaeoidea had similar intertransect depth distributions (Figure 44). *Penaeus duorarum* was an exception, with a modal occurrence at 37 m on the northern transect and at 18 m on the southern transect. Overall, 37 m stations yielded approximately 90% of all Hourglass specimens, the four most abundant species having modal distributions at this depth. Any species that did not have modal occurrence at 37 m was significantly less represented in our collections. Only two species, *Sicyonia stimpsoni* and *S. burkenroadi*, were not captured at 37 m, occurring exclusively at 73 m stations.

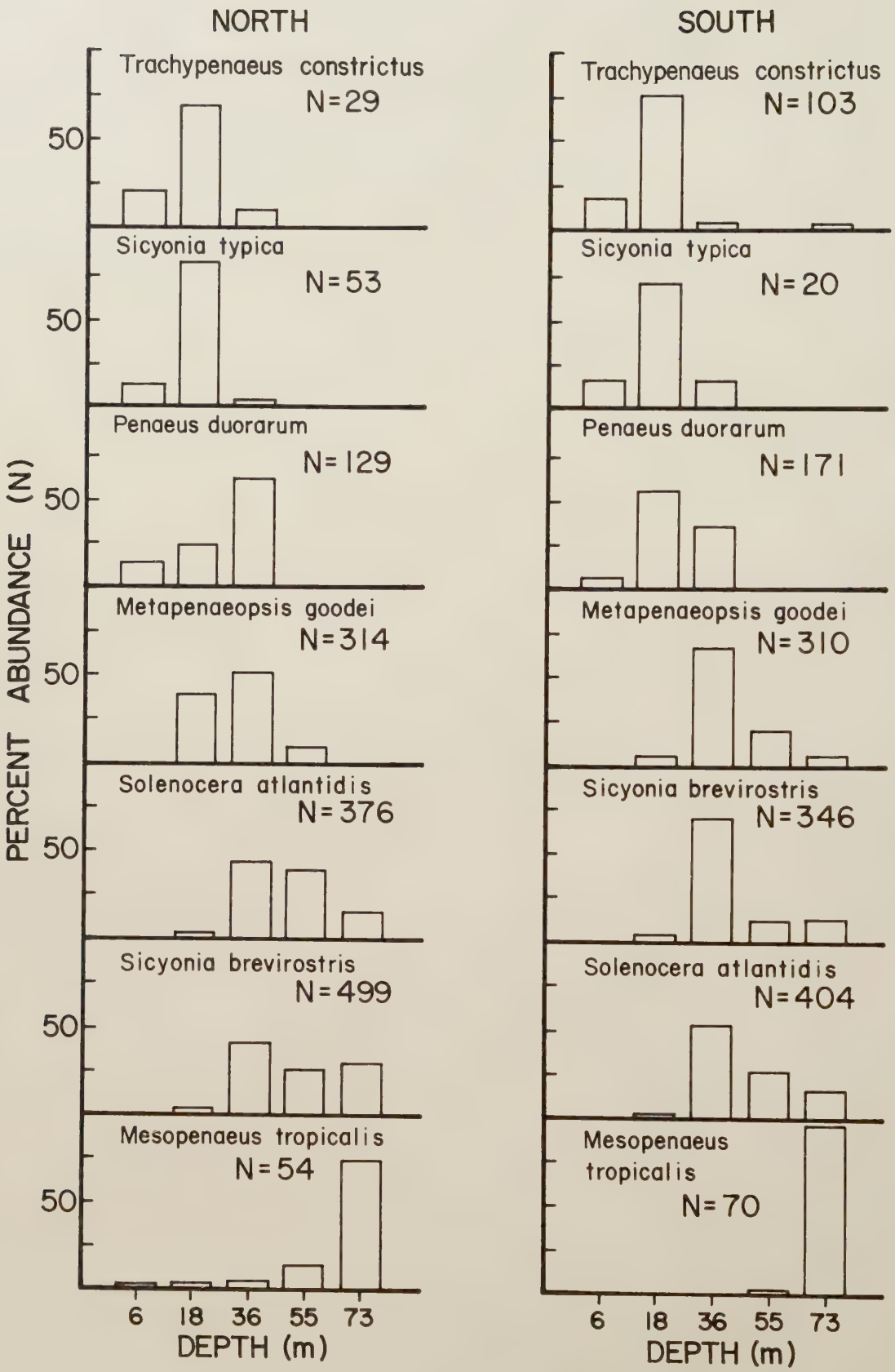


Figure 44. Intertransect depth/station abundance of seven Hourglass penaeoids during regular sampling.

Bottom temperatures varied similarly between the north and south transects (Figure 45). Mean bottom temperatures for both transects were similar, only slightly more extreme on the northern transect. Because intertransect temperatures were homogenous, this parameter probably had little effect on overall distribution of Penaeoidea on the central west Florida shelf.

Sex ratios for sufficiently represented species generally favored females. Only two species, *Penaeus duorarum* and *Sicyonia brevirostris*, had overall ratios approaching unity; all others ranged from 0.23 to 0.63 (male N/female N). Specimens of most species maintained a cumulative 1.00 ratio for smaller length categories, but females apparently outlived and outgrew males in all cases, dominating larger size classes. Effects of gear selectivity were considered minimal and observed sex ratios were probably indicative of Hourglass shrimp populations. Wenner (1972) assessed many marine crustacean sex ratios and characterized mechanisms responsible for normal or skewed patterns. He suggested protandric hermaphrodism as a possible cause for females dominating larger size classes. Alternatively, we consider two more likely mechanisms to be genetically determined high mortality of males soon after spawning cycles were completed, or differential predation by species which tend to select one sex of prey.

Maly (1970) evaluated sex ratios of copepods, concluding "that predators can alter the adult sex ratio in prey species if there is sexual dimorphism or behavioral differences between the sexes." Noncommercial Hourglass Penaeoidea had characteristically small males, but behavioral differences between sexes were not detected in our sampling. Possible ontogenetic mechanisms for skewed ratios could be evaluated by observing year-class changes of sex proportions. Apparent protracted spawning and recruitment of Hourglass species obscured observations of males dropping from the population with time. Such analysis could be performed on any species displaying sexually dimorphic sizes and definite spawning/recruitment periodicity. Predator selection for size/sex of prey might be evaluated by comprehensive examination of stomach contents, but not all potential predatory fish species stomachs were available for analysis.

Spawning in our study area was generally protracted, ranging from four months for *Sicyonia brevirostris* to possibly twelve months for *Solenocera atlantidis* (Figure 46). Two species, *S. brevirostris* and *Metapenaeopsis goodei*, had increased abundance associated with reproductive activity, suggesting aggregate spawning. *Trachypenaeus constrictus* displayed discontinuous spawning and abundance, revealing little about reproductive activities or strategies.

Temporal recruitment patterns were variously related to spawning (Figure 46). *Metapenaeopsis goodei* and *Solenocera atlantidis* had protracted recruitment consequent to their extended spawning period. However, *S. atlantidis* had a definite recruitment pulse in August. *Trachypenaeus constrictus* appeared as newly recruited shrimps about two months following the last month of spawning. Numerous, small *Sicyonia brevirostris* were recruited three months after cessation of spawning. Spawning and recruitment times for *S. brevirostris* were in general agreement with those reported for Florida's northeast coast (Kennedy et al., 1977).

Except for pink shrimp, none of these species apparently use estuarine nursery areas. Recruitment of small individuals ($\sim$3 mm CL) was fairly constant. Postlarval forms were often found 48 to 282 km offshore by Eldred et al. (1965) but were more common in shallower shelf areas. *Penaeus duorarum* were recruited to southern Hourglass populations at much larger sizes ($\sim$13 mm CL), mainly in October, reflecting a well documented migration of subadults from estuarine nurseries.

Stomachs of many species contained various amounts of smaller crustacean fragments (Table 22), constituting a major dietary component. Bivalves were found almost as often; polychaetes were an important secondary food source. *Trachypenaeus constrictus* and *Solenocera atlantidis* had very similar diets but evidently avoided direct competition by having different depth (habitat) affinities (Figure 44). *Penaeus*

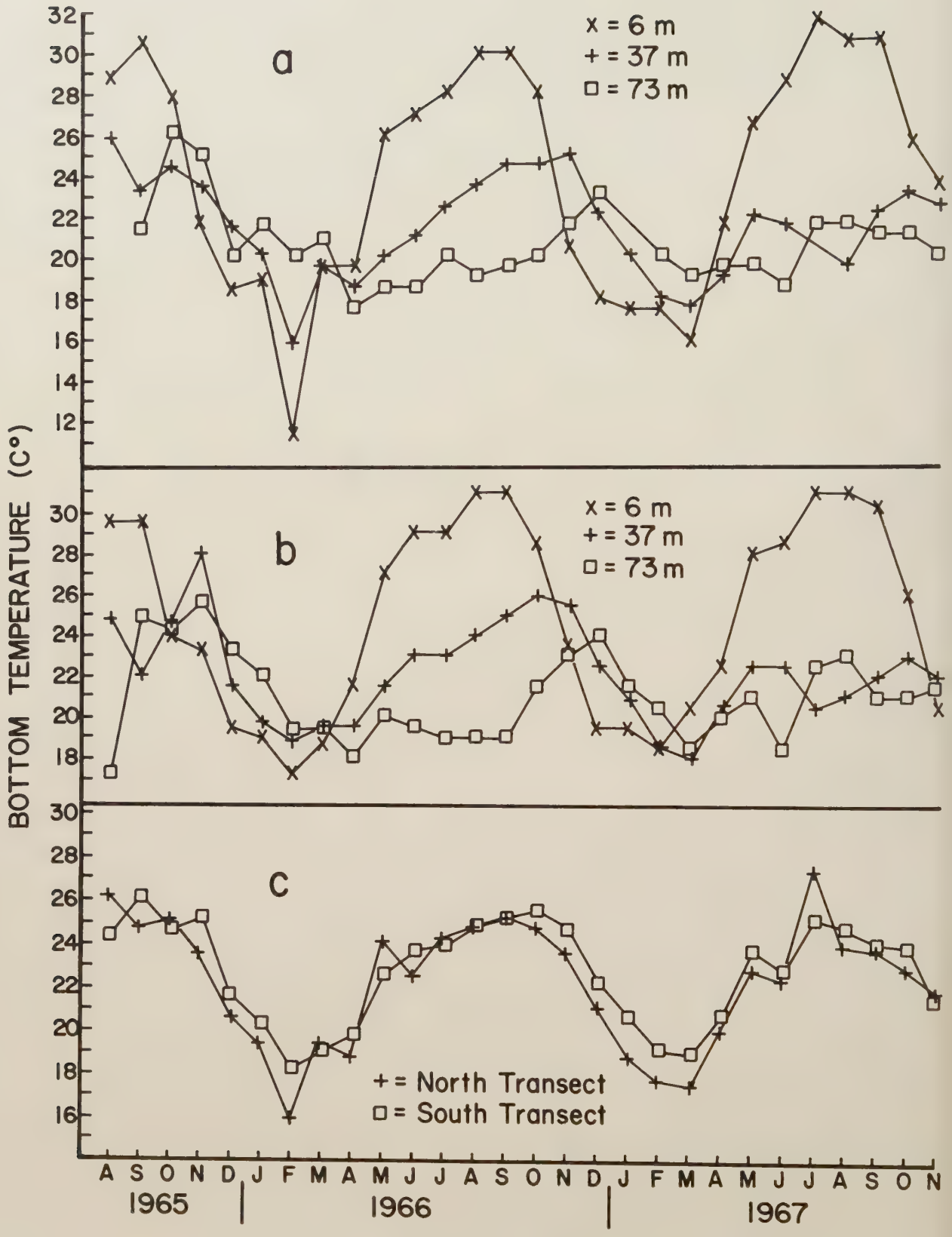

BOTTOM TEMPERATURE (C°)
a
x = 6 m
+ = 37 m
□ = 73 m
b
x = 6 m
+ = 37 m
□ = 73 m
c
+ = North Transect
□ = South Transect
A S O N D J F M A M J J A S O N D J F M A M J J A S O N
1965
1966
1967

Figure 45. Monthly bottom temperatures during regular sampling: a. northern transect; b. southern transect; c. mean for both transects.

duorarum and *Sicyonia brevirostris*, two large commercial species, depended heavily upon bivalve mollusks, their larger size allowing them to more readily masticate shell. Heterogeneous depth distribution for these two species probably ameliorated direct competition for a similar food source. Their increased ability to consume and greater dependence on mollusks decreased competition with other smaller Penaeoidea.

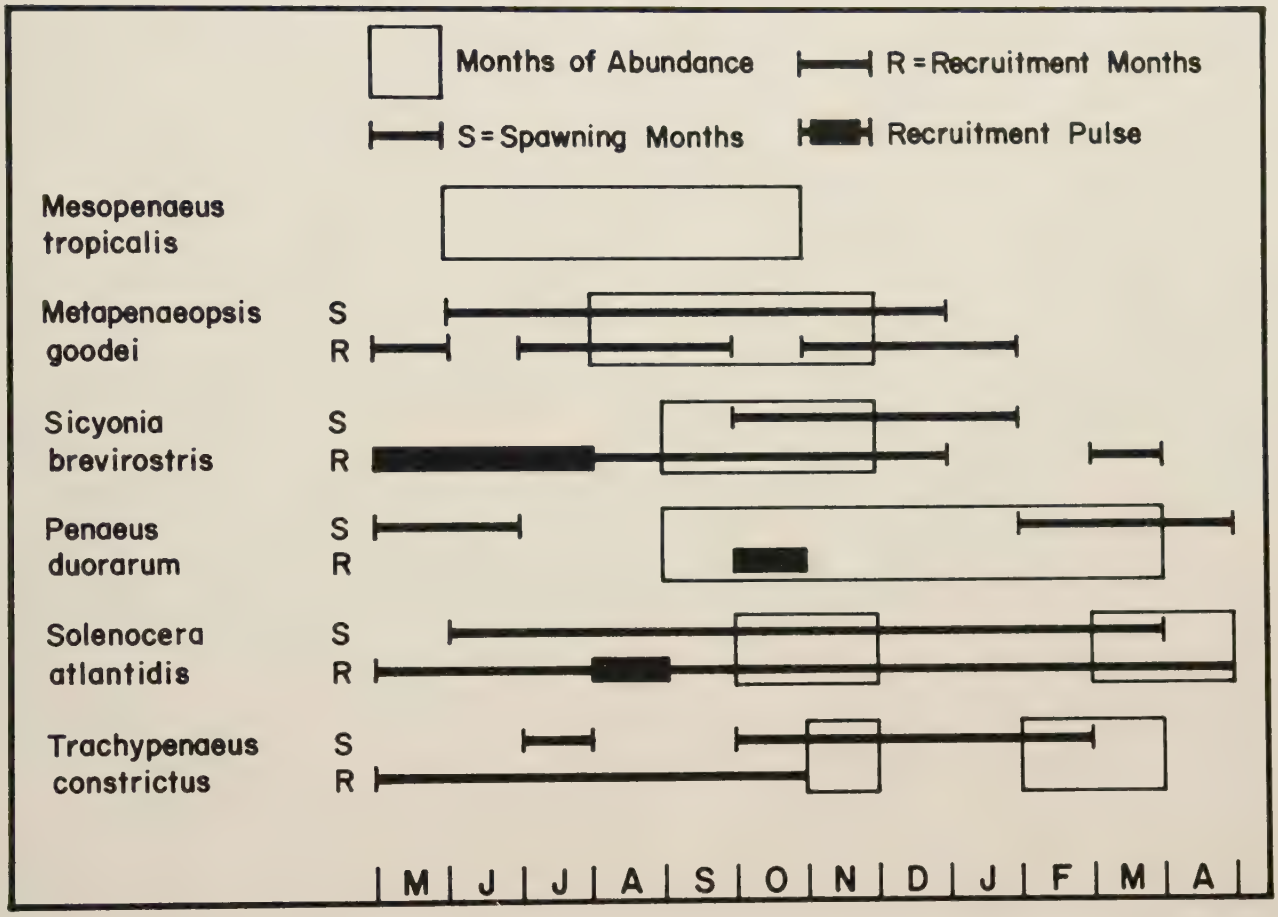


Figure 46. Times of abundance, spawning, and recruitment of some Hourglass penaeoids.

TABLE 22. PREDOMINANT FOOD ITEMS FOR SEVEN HOURGLASS PENAEOIDS.

Species	Predominant Food Items*			
	Unidentifiable Crustacea	Bivalvia	Polychaeta	Gastropoda
T. constrictus	38	38	38	
S. atlantidis	54	42	38	
M. goodei	52			
M. tropicalis	43			
P. duorarum		80		
S. brevirostris		72		
S. typica				54

*Percentage occurrence in stomachs containing food material.

Marine zoogeography of the western Atlantic is particularly complicated around Florida's Atlantic coast and in the eastern Gulf of Mexico. This area has warm-temperate (Carolinian) and tropical (West Indian and Caribbean) components, with faunal and floral transitions along both Florida coasts (Briggs, 1974). Penaeoidea caught in Hourglass sampling are found in both regions and seem not indicative of either one (Table 23).

Disjunct penaeoid distributions along the west Florida coast have been well documented and further substantiated by Hourglass results. Notably absent are *Penaeus setiferus, P. aztecus, Solenocera vioscai, Trachypenaeus similis,* and *Sicyonia dorsalis*. Systematic Hourglass sampling also indicated that *Parapenaeus longirostris* and *Xiphopenaeus kroyeri* are not part of the shrimp fauna of Florida's west central shelf. Hutton et al. (1956) listed abundant occurrences of *Penaeus aztecus* near Tampa Bay; these were assuredly *Penaeus duorarum*. Saloman (1964) reported a unique capture of *T. similis* at the mouth of Tampa Bay near Egmont Key. Substrates in this area did not favor establishment of *T. similis* populations; this occurrence was probably adventitious. *Xiphopenaeus kroyeri*, a littoral species which apparently prefers a very narrow depth zone (11-13 m) and soft substrates (Christmas and Etzold, 1977), has not been reported from this area in any other contiguous faunal survey.

Shrimp species present in the Gulf of Mexico but absent from the Hourglass area, including *Trachypenaeus similis*, have documented preferences for soft bottoms. Williams (1958) established the attractiveness of "softer, muddier substrates" to *Penaeus aztecus* and *P. setiferus*. Indeed, substrates appear to be the single most determinant factor of penaeoid distributions in the Gulf of Mexico. Burkenroad (1939) found *Solenocera vioscai, Penaeus setiferus, P. aztecus, Parapenaeus longirostris* and *Trachypenaeus similis* abundant in samples from off the Mississippi River; *Xiphopenaeus kroyeri* was rare. He described substrates as "fine clayey deposits ... without any considerable proportion of coarse sand or shell" associated with the "greatest influence of the Mississippi." He also noted the absence of *Solenocera atlantidis, Penaeus duorarum, Trachypenaeus constrictus, Sicyonia brevirostris* and *S. stimpsoni* between 88°06′ and 89°56′W (vicinity of Mississippi River mouth). Subsequent sampling by Franks et al. (1972) within these boundaries has found *Penaeus duorarum* and *Sicyonia brevirostris* around 88°30′W. However, they found the same penaeoid fauna as previously listed by Burkenroad (1939) with the addition of *Sicyonia dorsalis*. Substrates seemed similar to those described by Burkenroad, consisting of "silty mud and sandy silt" with some shell and organic debris.

Hourglass Penaeoidea came from substrates of primarily quartz-shell sand at 6, 18 and 37 m, and algal sand at 55 and 73 m (Gould and Stewart, 1956). As evidenced by Hourglass station descriptions, this area was penetrated by limestone outcroppings with occasional or frequent biogenic silt pockets or veneered by biogenic silt (Joyce and Williams, 1969). Substrates of the northern Gulf coast are generally predominated by quartz-shell sand except where influenced by sediments from the Mississippi or other large rivers (Burkenroad, 1939; Lynch, 1954; Gould and Stewart, 1956; Franks et al., 1972). The eastern Mexico shelf has a much steeper gradient, and various sedimentary regimes are apparently associated with depth and currents (Lynch, 1954). Consequently, Penaeoidea fauna, as described by Hildebrand (1954, 1955) is varied and less characteristic than on wider shelf areas to the north and east. Off the western coast of the Yucatán Peninsula, the shelf broadens to form the Campeche Banks where coarser sediments again predominate (Uchupi and Emery, 1968: Fig. 2). This transition to firmer substrates (shell, algal, coral and oolite sand) also marks the boundary between commercial brown or white shrimp grounds and commercial pink shrimp grounds (Hildebrand, 1954: Fig. 1); rock shrimp are also common here.

An apparent penaeoid assemblage associated with soft substrates throughout the Gulf is *Penaeus aztecus, P. setiferus, Solenocera vioscai, Trachypenaeus similis, Sicyonia dorsalis, Parapenaeus longirostris* and possibly *Xiphopenaeus kroyeri*. The probable penaeoid assemblage of firmer substrates, and that indicated by Hourglass captures, is *Solenocera atlantidis, Penaeus duorarum, Metapenaeopsis*

TABLE 23. WESTERN ATLANTIC DISTRIBUTIONS OF PENAEOIDS CAPTURED DURING HOURGLASS SAMPLING.

Species	Atlantic Coast of U.S. south of North Carolina	Northern Gulf Coast	Southern Gulf	Caribbean Coast of Central and South America	Brazil (Briggs, 1974)	Bahamas	Antilles
	-------Warm Temperate-------		----------Tropical----------				
S. brevirostris	X	X	X			X	X
S. atlantidis	X	X	X	X	X	X	X
M. goodei	X	X	X	X	X	X	X
P. duorarum	X	X	X				
T. constrictus	X	X	X	X	X		X
M. tropicalis	X	X	X	X	X	X	X
S. typica	X	X	X	X	X	X	X
S. laevigata	X	X	X	X			X
S. stimpsoni	X	X	X	X			X
S. burkenroadi	X	X	X	X			X

goodei, Trachypenaeus constrictus, Sicyonia brevirostris, S. stimpsoni, S. laevigata, and *S. typica*. These two groups are not mutually exclusive. There is considerable mixing in areas where a full range of substrates is offered, i.e., steeper slopes of nearshore continental shelves. Where shelf area is extensive and substrates more homogenous, these faunal assemblages and disjunct distributions are allowed to develop, becoming characteristic of those areas.

We noted an apparent functional population characteristic for *Penaeus duorarum* and *Sicyonia brevirostris* which may be applicable to other large commercial species. Exploited shrimp maintain both areal and temporal separation of adult and juvenile populations. Smaller Penaeoidea, as in our study area, lack one or both of these separations, tending toward protracted spawning and recruitment without use of a separate nursery area. Cause and effect relationships and evolutionary patterns are, at best, difficult to assess, but advantages of both areal and temporal separations are readily apparent. Such strategies limit intraspecific competition for habitat and food, possibly allowing and supporting an evolutionary trend toward both large individual size and greater abundance.

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APPENDIX I: *Sicyonia brevirostris*: SUMS OF SQUARES AND CROSS PRODUCTS OF MORPHOMETRIC RELATIONSHIPS.

Sex	Length	N	Σx	Σx^2	Σy	Σy^2	Σxy	Function
					Carapace/Total Length			
♂	all	174	3373.10	70481.61	12807.50	1015621.63	267471.57	Linear
♀	all	219	4677.80	109846.70	17106.60	1456456.82	399713.68	Linear
					Carapace Length/Weight			
♂	all	208*	597.10030	1739.99898	337.76884	817.68483	1052.82083	Exponential
♀	all	249**	733.95184	2206.81086	441.84286	1230.05304	1439.96620	Exponential
♂	<23	148	402.481742	1107.83012	168.54969	331.93006	501.24437	Exponential
♀	<23	146	392.77118	1072.11010	144.09000	295.23080	436.00250	Exponential
♂	≥23	59	1535.40000	40221.74000	1055.27000	19789.85050	27928.85700	Linear
♀	≥23	101	2840.30000	80922.19000	2059.15000	45830.05770	59861.49400	Linear

*Total includes one point not used in subsequent division of line.
**Total includes two points not used in subsequent division of line.